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Contributors and Contributions

Past-President James Hartness

Mr. Hartness, who contributes the article in this issue on "Optical Projection for Screw-Thread Inspection," has made a study of the niceties of thread cutting for many years in connection with the manufacture of the Flat Turret Lathe. He was one of the first to manufacture dies with the cutting teeth corrected in order to produce threads of accurate pitch. His present contribution was suggested by his service on the National Screw Thread Commission appointed a few months ago by the Department of Commerce. Like Mr. Hartness' past contributions to the engineering arts, it bears the characteristic of marked originality.

Prof. A. G. Christie

Professor Christie, Associate Professor of Mechanical Engineering, Johns Hopkins University, Mem. Am. Soc. M. E., has specialized in steam engineering and was employed for a time last summer on certain problems for the U. S. Shipping Board. As a central-station man he raised the question, which he discusses in a paper on Marine Practice in Valves and Fittings, presented before the Baltimore Section, as to why central-station equipment should not be more generally used on shipboard. In fact, with the fabricated, or manufactured, ship, is it not most logical to use standardized and manufactured equipment in the way of valves, piping, fittings, etc.?

E. A. Uehling

One of the strong papers presented at the last Annual Meeting was that on the Chemical and Physical Control of Boiler Operation, in which the author shows by actual example certain calculations which may be made from data given by recording-instrument charts, with a view to increasing the efficiency of power plants. Mr. Uehling joined the Society shortly after it was founded. As President of the Uehling Instrument Company and through long experience in the manufacture and use of recording instruments, he has been enabled to make several valuable contributions on this general subject. A copious abstract of the one mentioned is given in this number.

F. G. Coburn

Supplementing the addresses at the Annual Meeting on the engineering accomplishments of the Army and Navy during the war, we are enabled to give a descriptive account of the organization of the immense naval aircraft factory erected and put into operation at the League Island Navy Yard in 15 months' time. The data for this article were supplied by Commander Coburn, the manager of the undertaking, a member of this Society who was formerly at the Boston Navy Yard, where he was engaged in organizing and developing manufacturing processes.

Edwin J. Prindle

Some time ago a committee was appointed by the National Research Council, at the request of the Commissioner of Patents and with the approval of the Secretary of the Interior, with a view to making recommendations for improvement in the Patent Office and the patent system. The report was concluded just in time for Mr. Prindle to present his own personal views on the matter at the New York meeting of January 14. Just as Mechanical Engineering was going to press the report itself was released for publication, and through Mr. Prindle's interest in the Society as a member we are enabled to give this report.

Harold Medway Martin

It is the policy of the Publication and Papers Committee to extend the reviews of leading articles which appear regularly in the Engineering Survey section of Mechanical Engineering as rapidly as space and funds will permit. Occasionally papers and articles of unusual merit appear, which it is deemed desirable to abstract comprehensively, as has been done in this number with the series of articles by Professor Martin in London *Engineering* on A New Theory of the Steam Turbine. Professor Martin is the author of a book on the Design and Construction of Steam Turbines and is connected with the City Guilds Institute, London.

Dr. Frederick G. Cottrell

Another timely article and one which puts on record another industrial accomplishment of the war is that on the Production of Helium from Natural Gas, based on an address by Dr. Cottrell, Chief Metallurgist of the Bureau of Mines, at the Chemists' Club, New York, on January 17, at which time he received the Perkin Medal. Helium is a non-inflammable gas heretofore not available in large quantities, which it is proposed to use in balloons, and which it is anticipated may make transportation by dirigible a fairly safe proposition. The production of helium is a mechanical and thermodynamic process, and several members of the Society have been engaged in carrying through the development work to a point where it appears to be successful. Although the time was very short for preparing this material for the February number of Mechanical Engineering, we were enabled through the helpful assistance of Dr. Cottrell to give not only an abstract of his address tracing the history of the development, but a supplementary analysis of the cycles of operation for the several systems which have been under experimentation by the Bureau of Mines.

Besides the Foregoing

Lieut.-Col. J. E. Cassidy, U. S. A., who stirred his audience at the Spring Meeting at Worcester with an account of his experiences in France, contributes another stirring account entitled "Over the Top" in France.

President M. E. Cooley outlines the principles by which he has made his appointments on the Society's committees; there is a comprehensive review of the reports by Sections' delegates at the Annual Meeting; a report of progress of the Screw Thread Commission; and of Government action on recommendations of the committee on Standardization of Gages. Arthur M. Greene, Jr., Chairman of the Research Committee, begins the department "Engineering Research" to be conducted hereafter in the columns of Mechanical Engineering by the Research Committee.

Spring Meeting

Reserve the dates of June 17, 18, 19 and 20. These are the dates of the Spring Meeting to be held in Detroit, when there will be an opportunity to visit the greatest manufacturing plants of the country and join in the social events which our Detroit friends are arranging for the membership, besides attending professional sessions of sterling merit now being planned by the Committee on Meetings and Program. Members who attended our Detroit convention eleven years ago remember it as one of the Society's finest and most interesting meetings. All may rest assured of a proportionately greater meeting this year commensurate to the growth and development which has taken place during the past decade in the industrial life of Detroit and the organization and membership of this Society.

Coming Sections Meetings

February 4: An all-day meeting is planned by the Cleveland Section as follows: Morning Session: Paper on Rubber by Professor Simmons of Akron, O.; paper on Electric Traveling Cranes by Mr. Shem of Alliance, O. Afternoon Session: Professional meeting and inspection of National-Acme plant. Evening Session: Dinner at 6 p. m., followed by addresses by Mr. Otis of Cleveland and Colonel Barnes of Washington on Railway Artillery.

February 8: The Philadelphia Section is planning a combined meeting of the Philadelphia and Wilmington members in Wilmington. The meeting will be preceded by an excursion of the Philadelphia members to Wilmington and a visit to the local plants of the du Pont Company. There will be a dinner at the Hotel du Pont, followed by the meeting in the evening, which will be addressed by one of the du Pont chemists, a member of the Society.

February 12: Prospective meetings are scheduled in New Haven and Providence. For the latter, the Providence Engineering Society plans to hold its Annual Banquet either on this date or some time during the week of the 12th.

February 13: The San Francisco Section will hold a meeting at the Engineers' Club, the subject being "The Present Status of Electrical Arc Welding," by F. A. Anderson, Electrical Inspector of the United States Shipping Board.

February 22: An organization dinner-meeting of the engineers in Havana, Cuba, is planned under the auspices of the members of the A.S.M.E.

February 25: Meeting of the Philadelphia members, at the Engineers' Club: "What Will We Do with Our Returned Aviators and Their Battle Planes?" Mr. Joseph A. Steinmetz, Mem.Am.Soc.M.E., of the firm of Janney, Steinmetz & Co., will speak.

MEETINGS HAVE BEEN SCHEDULED ALONG THE SECRETARY'S ITINERARY AS FOLLOWS:

February 1:	Dinner-meeting of the members at Atlanta, Ga.
February 3:	Evening meeting at Birmingham, Ala.
February 5:	Get-together meeting of the members in Tulsa, Okla.
February 6:	Evening meeting at St. Louis, Mo.
February 7:	Informal meeting in Kansas City, Mo.
February 8:	Visit with the officers of the Iowa Engineering Society.
February 10:	Meeting of members of the Minnesota Section.
February 13:	Meeting of Milwaukee Section, in the evening.
February 17:	Meeting of the members at Cincinnati, O.
February 19:	Informal meeting with the members at Erie, Pa.

OPTICAL PROJECTION FOR SCREW-THREAD INSPECTION

Analysis of Screw-Thread Elements Essential to Strength and Dependability—Description of a New and Improved Method for Their Accurate Inspection

By JAMES HARTNESS,[1] SPRINGFIELD, VT.

THE screw, one of the most important elements in mechanism and found in nearly all forms of machinery, is invaluable as a means for fastening two parts together, as a means of precision adjustment, and as a means of transmitting power.

In machines in which the weight must be kept as low as possible, as, for instance, in the airplane, it is of prime importance to have the screw as small as consistent with the strength and reliability required.

On account of the vagueness of our general knowledge of the conditions under which it takes its stress, we frequently underestimate the importance of the screw, and, through ignorance, continue practices that greatly increase the hazard of life in travel by rail, automobile or airplane, as well as lessen the reliability of performance of other pieces of machinery. A screw-thread fastening is very dependable if the two component parts are properly fitted.

While it is not possible to attain perfection in this work, an analysis of the various elements that are essential for strength and dependability, and the reduction of weight, will greatly simplify our efforts and make it possible to attain a point much nearer perfection.

Briefly stated, a screw's reliability depends upon the following elements:

a Material
b Form of profile of the thread
c Diameter of the screw
d Lead or the number of threads per inch.

After the foregoing general characteristics have been determined, we must consider the following details which depend on the methods and skill employed in production:

1 Smoothness and density of surface
2 Fit, which relates particularly to the exact relationship of the size of the two component parts
3 Precision of lead, which relates to the precision of advance of the helix or degree of precision with which the number of threads per inch are made
4 Uniformity or steadiness of advance of helix
5 Form, relating to contour of a single thread
6 Roundness, as relating to the circular path of the helix
7 Parallelism or taper.

These elements are all interrelated.

Modern practice in constructing machinery is drifting more and more toward absolute interchangeability of parts. In the older practice it was customary to fit one part to another, either by doing the final finishing at the time the parts were assembled or by selective process, such as picking out the larger screws to be used with the larger nuts or tapped holes and smaller screws to be used with smaller holes.

To a certain degree this method of fitting at the time of assembling, either by changing the sizes of the parts that go together or by selective process, is still necessary in the highest requirements of very close fits, but the trend is strongly toward perfect interchangeability.

This requires working to stated standards so that the size of the thread of the screw and nut will never exceed certain boundaries. But whether the boundary allows no freedom when the largest screw is turned into the smallest nut or a certain predetermined freedom of play, there still remains the necessity for determining how large an internal thread may be made and still be acceptable, and how small the screw may be made and still be acceptable; in other words, what is the greatest degree of looseness that can be tolerated without impairing the dependability of the screw and nut for service.

Thus far we have had no satisfactory way of specifying all of the elements that are required to make a screw dependable, but we are now finding that the projection lantern offers a better method and makes it possible to simplify specification and practice.

The Fit of Screws in Relation to Their Diameter

It will be understood that the largest percentage of screws must be made with sufficient play to make it possible to screw them together rapidly by hand, and resort to the wrench only for setting them up to full tension. This is essential for convenience of assembling, which is an important part in the production of the machine, and for the use of the product in service.

As an example we may take the bolts of the demountable tire rims of the automobile wheel. The nuts for these bolts should be a reasonably good fit. At the same time, in order to get quick interchangeability, they must not fit too close; that is, they must turn with a certain degree of freedom, yet the service they render is so important that they must be a little closer than a wringing fit, but must not be a tight wrench fit, at least at the outer end of the screw. While the limits of a screw fastening for this service are very small, the case illustrates the fact that a given degree of freedom of play is necessary, but must not exceed a certain boundary. In certain kinds of agricultural machinery, for instance, a much larger freedom may be tolerated, and in fact is desirable.

The gaging not only determines this boundary line, but also establishes another boundary line which constitutes the maximum freedom of play of the two components.

For instance, a ¾-in. 10-pitch screw, nut or bolt measures ¾ in. at the largest diameter (called crest of the thread) of the bolt, but since the crest is not of great importance, we measure the screw at the flanks of the thread with V-point calipers. This we call the pitch diameter, expressed P. D. The P. D. of a full-sized ¾-in. (0.750-in.) bolt is 0.6851 in. This we call the basic diameter for this thread. In general practice it constitutes the maximum size for a close-fitting screw, and in some instances the smallest size of the nut. In other instances, the smallest nut is made a few thousandths of an inch larger in order to give a certain degree of looseness.

If the smallest nut is made to this basic size, then this figure becomes the minimum boundary of the nut and the maximum boundary of the screw.

Since it is not practicable to produce screws of exact uniformity, it is customary to allow a certain range of variation. The range of variation is expressed in thousandths of an inch of tolerance.

For instance, for fairly good work we allow a range of two and one-half thousandths of an inch, usually expressed as 0.0025 in., and sometimes given in exact size, such as in this case would be 0.6826 in., which is 0.0025 in. less than basic size, 0.6851 in.

The tolerance of variation in diameter of the nut in the same way is expressed as 0.6851 in. as minimum size plus 0.0025 in. for maximum of 0.6876 in.; or, if there is to be a neutral zone between the largest screw and the smallest nut, then the smallest screw may be any size that meets the requirements, 0.006 in. being a certain ordnance practice for neutral ground. Then the P. D.

[1] President, Jones & Lamson Machine Co.; Vice-Chairman, National Screw-Thread Commission; Past-President Am.Soc.M.E.

of nut becomes 0.6911 in. for minimum to 0.6936 in. for maximum, the tolerance of variation of product remaining the same, 0.0025 in.

In the old practice of fitting one piece to another, or even in the selective fitting, it was a comparatively easy matter to keep within certain boundaries between two pieces, but in the new practice, if the total freedom of play between two parts is 0.004 in., and the minimum freedom of play between two parts is 0.001 in., we will see that it is necessary to have 0.001 in. for the neutral space and divide up the other 0.003 in. in tolerance in variation in the sizes of the two component parts of the screw-thread fit. If the tolerance is equally divided between the two parts, this makes a total variation of 0.0015 in. that will be tolerated in the nut and 0.0015 in. tolerated in the screw.

The interchangeability system therefore imposes upon us greater precision in uniformity of production in order to get this interchangeability; but notwithstanding this important handicap, the advantages of the interchangeability system are so great as to offset the disadvantages. In fact, a high degree of interchangeability brings a reduction in cost of product and a greater reliability.

The purpose of our gaging is to guide us in manufacturing these parts and to serve as a means for finally inspecting the work before it is put into service; for if a screw, for instance, is made by one manufacturer or department and sold to or delivered to another manufacturer or department, the screw must be passed upon by suitable gages to determine whether or not it comes within specified boundaries.

Fit of Screws in Relation to the Helix and Form of Thread

The form of the United States Standard thread, originally known as the Sellers Standard, is made by a cutting tool having an included angle of 60 deg. This tool is truncated or flattened off at the end to an extent that amounts to one-eighth of its travel per revolution. The top of the thread has a similar flat, and although this describes a perfect thread, it is well known that a perfect thread is seldom found in practice. Therefore, it is our object in gaging and inspection to measure not only the diameter and the various parts of the screw, but also the truth of the helix for a given advancement per revolution, the degree of departure of the screw thread from the specified 60 deg. of angle, and, in fact, each characteristic on which its form and reliability depends.

Threads are specified as having a lead of helix expressed by the number of threads per inch. For instance, a ¾-in. United States Standard screw has 10 threads per inch. It is essential that there should be as nearly as may be exactly that number of threads per inch. If we count off 10 threads on a screw and find that we have advanced more or less than 1 in., we say the lead is not true; that it is off so many thousandths of an inch.

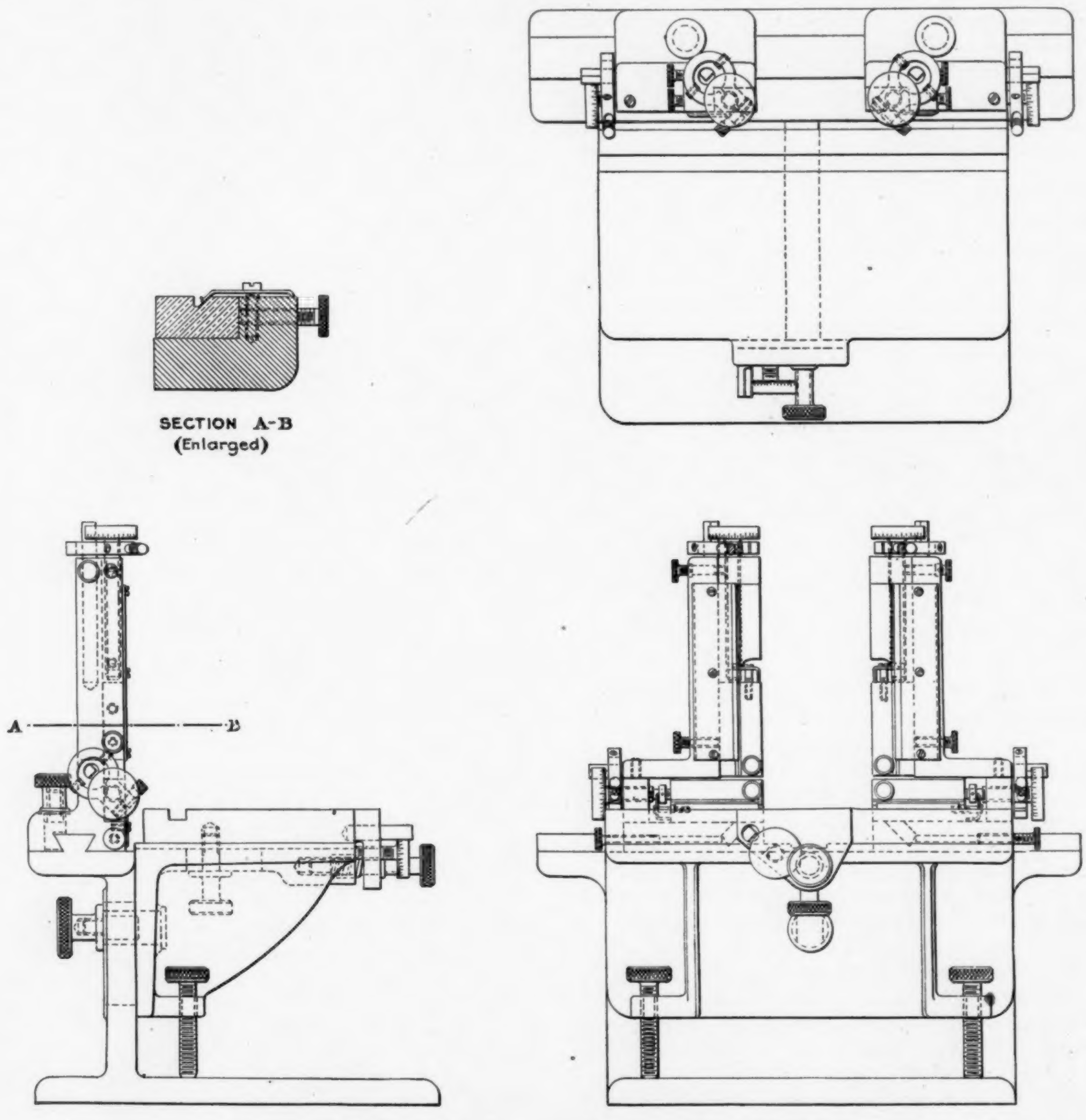

Fig. 1 Projection Machine for Inspecting Screw Threads

If the lead of a ¾-in. screw is "off" more than 0.003 in. or 0.004 in. per inch of length of engagement, it is unsuited for the best work, for when screwed into its threaded hole, which we will assume is accurate, the threads will not match; consequently, if they are of approximately the same size, the two may not screw together. But let us assume that the diameter of the inner member is enough smaller than standard to offset the difference in lead; then, although the two may screw together. they become less dependable when subjected to stress than if the threads of the two component parts matched each other; for it is obvious that there would not be an equal distribution of the stress of the work on the various threads that should be engaged.

Thus it will be seen that we not only have to consider the diameter but the lead, and in addition to this the form of the thread; that is, the form as shown by taking a profile that shows the flats of the angles of the sides. Then, since the helix may not proceed uniformly, may stagger forward, producing a thread which is known as a "drunken" thread, we must know about the degree of uniformity of this advance.

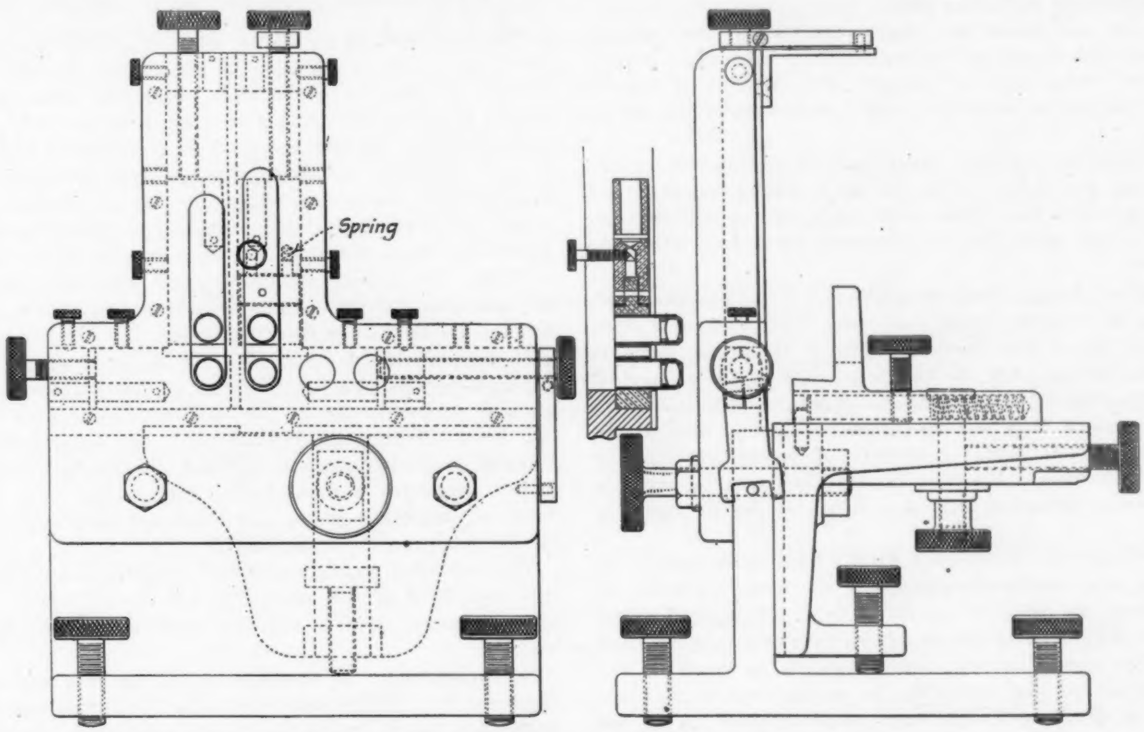

Fig. 2 Machine Designed for Smaller Range of Work

Besides this, we have to determine the roundness, for die-cut threads are frequently "out of round," due to excessive clearance of the cutting tools and inequality of distance between the two pairs of cutting edges in a die having four cutting edges.

We have also to inspect the screw for character of its surface. A die-cut thread, especially threads of 10-pitch and coarser, may be very rough and a microscope may show its surface as mountainous.

Furthermore, in addition to the measurements and character of its surface, the entire surface, including the tops and sides of the "mountains," may be, as expressed by one authority, "like a plowed field," as a result of the action of the cutting tools which, instead of cleanly removing the metal, have pushed or torn out the metal as if pulled out by the roots. This analogy, of course, is not perfect, but it gives a fairly true conception of the character of the surface, especially of a screw that has been produced by a single passing of the die.

Although some screw-cutting dies are designed to supplement the cutting process by a burnishing process which levels the "mountains" and compresses the "plowed-field" surface, the fact remains that nearly all screws of pitches coarser than 10 or 12 per inch have rough surfaces.

It is customary for the inspector to pass upon surface characteristics by close scrutiny. If it appears smooth, the screw is accepted, and if it is unduly rough for the service for which the screw is to be used, it is rejected.

Deficiencies of the Usual Gaging Methods

The process of gaging screws by the use of ring gages for the screw and the plug gage for the threaded hole is far from satisfactory for many reasons. The best practice uses at least two gages for each part. In gaging a screw, for instance, two ring gages are required. One is the upper boundary of size into which the screw must easily turn with a finger fit. The other gage is the lower one into which the screw must not enter more than one or two threads, according to the condition of the gage and the work.

In still finer practice other gages are used to determine the lead, form and diameter of the crest and root, but in all such gaging processes the gage merely rides over the tops of the mountains, so far as the surface is concerned, and the extremes of the irregular helix, so far as the wabbling of the lead is concerned. Thus it will be seen that even with the best practice in use of the ring and plug gages, the process of gaging does not give a true indication of the dependability of a screw as a means of fastening.

A ring gage which is used for testing screws may become deceptive by the possibility of a fine, thin chip becoming lodged at some invisible point in the valley of the thread. For instance, if this is in a "no go" gage, and if the practice of the plant is to allow a screw to enter one or two turns into the "no go" gage on account of the wearing of the gage, a screw may enter until it encounters a chip of this kind; and then, since it can go no farther, it is passed as acceptable because it will not enter the "no go" gage beyond a specified distance for that particular gage.

The other elements of uncertainty readily come to the mind of one accustomed to precision measurement, and it is not necessary to go into all of these details.

In addition to the ring gages, we have the adjustable caliper in the form of the regular micrometer and the thread micrometer, and the fixed calipers, in which the points, although adjustable, remain fixed so far as the workman is concerned. These calipers, whether fixed or adjustable, give the diameter of the thread, usually measuring it on the flank, but this diameter does not give

a true indication of the roundness of the screw. For instance, if the screw is die-cut, the advance of the cutting of the die may be irregular, so that although any two opposite points in the diameter of the screw may be uniform to a certain measurement, as a matter of fact the screw has wabbled in passing through the die so that it has a series of longitudinal flutes or waves of more or less amplitude.

The caliper points for such work will find substantially a uniform diameter, although on one side one point of the caliper may be resting on a crest, while on the other side of the work the other point may be in a valley.

In the usual methods of inspecting there is also to be considered the personal equation of the inspector.

We speak of loose fits as "very loose," or with "very little shake," or still closer with "no shake."

Close fits are designated as "finger fits" when they can be turned on with the finger, as "wringing fits" when they require a little greater force, and as "wrench fits" when they require more force than can be exerted by the hands without the aid of wrench.

These are some of the shop terms that are in common use between men who are skilled in the work of making screw-thread fits of a dependable kind. They were fairly satisfactory between men skilled in this work, but they become misleading when put in general use.

To the skilled worker they meant that the fit for two component parts of a screw-thread fastening that were of known lead, shape of thread and fineness of finish, should be made to satisfy this tactile test, but the tactile test leaves the science of screw-thread gaging in a most difficult situation, especially with the modern advance in which specialization has so divided the work that the various parts of a piece of mechanism may be made in different cities. A screw, for instance, may be made in one city, and the threaded hole into which it fits be made in another city.

When we realize that for a close fit the total allowance is extremely small, and wholly disappears by the usual variation in machine product, we begin to see the difficult situation that has come with the higher development of machine construction, and we see that this tactile method, which depends so much on the personal equation of the individual inspector, leaves the producer always in doubt as to what will be acceptable, for he has no positive indication of the ruling of the purchaser.

Gages Do Not Definitely Determine Shape and Character of Thread

What has been said thus far applies merely to gaging screws that are known to be correct both in form and finish of surface. A simple plug or ring gage gives no indication of the exact form of a thread. In fact, when these gages are supplemented by others cleared at the root and crest, we are still in doubt as to the form of the effective surface. With this important element unmeasured, our gaging system is incomplete, even if it were satisfactory in other respects.

Thus far, also, we have considered the two component parts of a screw-thread fastening as if made of material that was neither elastic nor plastic. If this were true, our screw threads would be most undependable, but since it is not true, and since the threads of the two component parts may be forced together under wrench, or subjected to the stress of work, the engaging flanks of the threads of the two component parts are gradually squeezed into fitting surfaces. The stress levels the "mountains" and compresses the surface, and if the angles of the flanks of the two threads are not similar, this stress to a certain degree compresses the metal into a shape that gives perhaps a nearly perfect form of contact.

This squeezing changes the size and form of the thread surface and hence our gages cannot indicate what the shape and diameter of the screw will be when these "mountains" have been leveled and the "plowed-field" surface compressed by the action of the working stress.

Our gaging method is such that we must never exert pressure that will level down this surface, for by even the most careful use the gage wears out of shape, and it is considered very bad practice to force a gage.

Thus it will be seen that although we use our greatest care in the measurement of the screw thread as it comes from the machine in which it is produced, our gaging system makes little recognition of the shape, form and dimensions of that screw after it has been put under its working stress. It must be remembered that nearly all screws, excepting those used for precision adjustment, must be subjected to considerable stress in service, and that the end and aim of our gaging system should be to determine the fitness of a screw for its service.

Screw-Thread Requirements in Advanced Practice

The advancement of the art which has come about through the development of the bicycle, the automobile and the airplane has reached a point in which it is absolutely necessary to inspect screws in a way that will give a much better indication of their dependability. Before the art had advanced to this point where it was necessary to obtain the greatest strength for a given weight, a simpler system of gaging was satisfactory, but now, to make the most dependable airplane, a screw thread should be gaged for form, diameter, pitch, roundness and compactness of surface. The gaging should be done with full consideration of the changes that are produced in the lead, form and diameter when subjected to the working stress.

It seems probable that with the advance of requirements in machine construction we must go a step further in our gaging methods and make use of the projection lantern to help us solve our screw-thread gaging problems. The optical method of inspection and measurement of screw threads by the use of microscopic apparatus and projection lantern has been found invaluable in inspecting gages, but it has not been generally used for the inspection of the work itself.[1]

The tactile or touch method of inspection does not give us a true indication of the form of a screw, and even with a variety of instruments it gives only an approximate conception of the lead.

Notwithstanding the shortcomings of the ring and caliper types of gages, they still remain among the most practical gages in the workman's hands; and although the projection lantern brings the gaging to a definite science, and should be the basis of specifications for screw threads and the final arbiter in accepting or rejecting the product, its function is more to keep a check on the simpler forms of gages than to supplant them.

For instance, the first and last pieces of a lot of die-cut screws should be tested by the lantern. A change of dies, either through wear or important adjustment, should be checked by sending a sample screw to the lantern. This supplemented by the percentage test of the final product would be sufficient check, for it would give a definite knowledge of the character of the form, lead, roundness, etc.

The projection lantern has been developed to a point where it now gives at a glance the diameter, lead, form, and a fair indication of the roundness and smoothness of the surfaces. In order to get all of these results it is necessary to use in connection with the projection apparatus a stage and tolerance chart laid out on a large scale to conform to the desired characteristics of the screw to be inspected.

The chart is so located that the profile of one or more threads of the screw may be projected on to the chart and a comparison made between the enlarged shadow thus cast by the thread and the form of thread and tolerances outlined on the chart. (A more detailed description of the projection apparatus and chart is given later.)

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[1] The work that has been done in the development of this method for testing gages is set forth in the paper of Mr. H. L. Van Keuren, presented at the 1918 Annual Meeting of the Society (see The Journal, November 1918, p. 913). Mr. Van Keuren as Chief of Gage Testing at the U. S. Bureau of Standards describes the excellent work under Dr. S. W. Stratton, Director, and also mentions the pioneer work of the National Physical Laboratory, Sir Richard Glazebrook, Director, and the progressive work of Mr. H. J. Bingham Powell at the British War Mission, New York City. For information regarding such use, see publications of these institutions.

Advantages of the Projection Method of Inspection

The advantage of the projection method is that it is possible to see at a glance how a screw will fit in its threaded hole as represented by the tolerance chart on the screen. If only one thread is projected on the screen, this is raised or lowered by variation in diameter and displaced laterally by variation in lead. The combination of these two things must be known in order to know how the screw will fit into the threaded hole. If two threads are projected we have a knowledge of the parallelism or taper of a screw.

In the Progress Report of the Committee on Limits and Tolerances in Screw Thread Fits, presented at the Spring Meeting of The American Society of Mechanical Engineers in 1918, tables will be found showing what reduction in pitch diameter must be made to offset certain errors in lead. For instance, the basic pitch diameter of the $\frac{3}{4}$-in. 10-pitch screw is 0.6851 in., and if the lead of the screw is true, the pitch diameter may be made up to this full diameter; but if the error in lead is plus or minus 0.002 in. in the length of engagement, then the pitch diameter must be reduced 0.0026 in.

Even in the best work, however, such allowances for difference in lead are seldom calculated. We merely know that if the lead is "off" we must reduce the effective diameter.

By the use of the projection apparatus and the tolerance chart all elements excepting the density of surface may be seen at a glance. The resultant effect of the displacement in lead, diameter and angle from the boundaries established on the tolerance chart indicates the fit with a definiteness that will be beneficial alike to the producer and the purchaser, for it will make it possible for the purchaser to express in words and by diagram the exact boundaries within which the product must come.

In addition to providing a measure for the lead and diameter, the tolerance chart and projection apparatus provide a way by which it is possible to indicate the extent of variation in the form of the thread that will be tolerated.

As the art of machine building advances and our methods for producing and gaging screw threads advance, we shall doubtless soon arrive at a point at which we will find it desirable to indicate the difference in lead between the two component parts of a screw-thread fit. For instance, stress of work on a bolt or nut tends to lengthen the screw and compress the nut, so that if the leads of the thread in the screw and the nut were equal when free from stress, there would be an unequal distribution of the load on the various threads engaged when the two members were under a heavy stress.

The stress on a set screw compresses the screw, and to get equal distribution of load on each thread the set screw should be long in lead when free from stress, and the lead of the bolt and nut should be longer in the nut than in the bolt.

To meet such demands the projection-lantern scheme furnishes a solution of one half of the problem, for gaging is half of producing the work. If we have a practical and ready method of gaging, it is much easier to produce the work. By the use of the projection apparatus the specifications may call for cap screws showing the displacement due to lead in one direction, and set screws in the opposite direction.

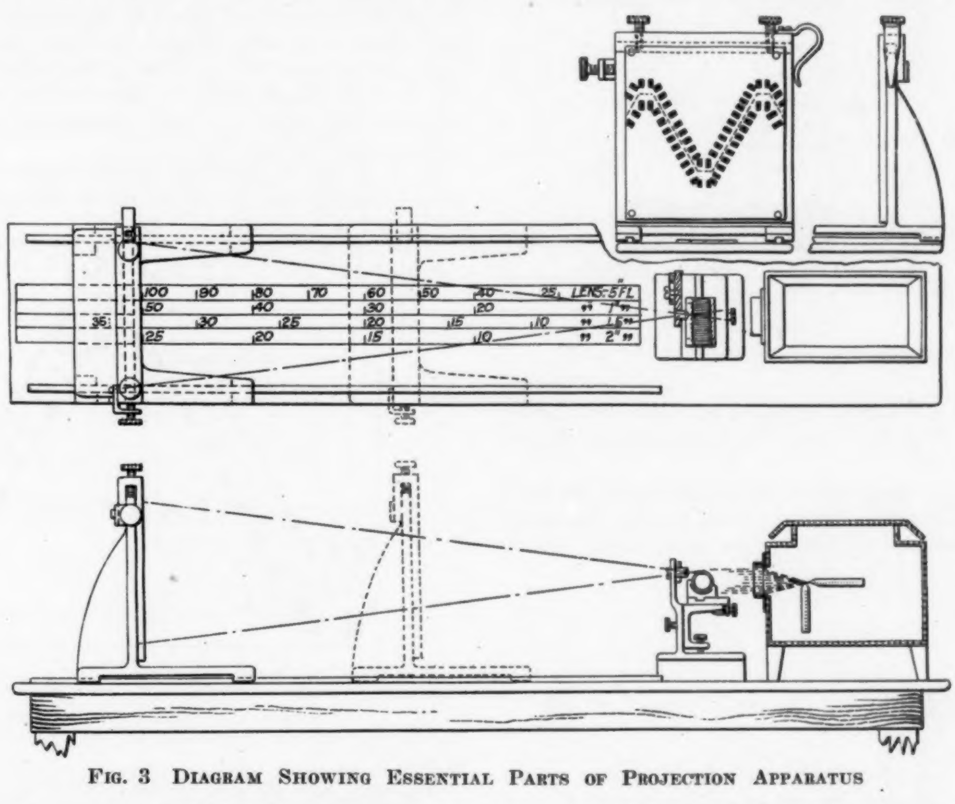

Fig. 3 Diagram Showing Essential Parts of Projection Apparatus

Measurement of Internal Threads

While the projection apparatus does not provide a solution for the measurement of the internal thread, it does provide means for measuring the tap which is used for producing the internal thread, and although it is well known that the usual way of measuring a tap does not indicate the exact nature of the threaded hole that will be produced by that tap, it is probable that a complete inspection of the tap by the projection methods will bring a closer harmony between the meaurements of the tap and the threaded hole produced by it.

Furthermore, the advance of machine construction has demanded for a number of years a greater refinement in tap making, and although the most progressive companies in this work have shown a remarkable advance in this respect, we are undoubtedly coming to a time when taps will be lapped or ground after hardening to bring them into greater uniformity.

Thus it seems that the advent of the projection lantern into the workshop for testing a certain percentage of the work produced will result in making our airplanes and other machines which operate under great tension for given dimensions more dependable and more efficient, and at the same time get a greater return for the energy that is put forth in the workshop in producing these things, for no one thing has been a greater barrier to our progress, especially in our recent war activities, than the uncertainty in our methods of specifying, producing and testing screw threads.

Description of Projection Apparatus and Chart

Fig. 1 represents a machine in use at present, excepting as it has been modified from time to time with various forms of work supports. Fig. 2 indicates a machine designed to take a smaller range of work.

Fig. 3 gives a side elevation and plan of the general scheme, although not true to proportions. The lamp house, for example, is shown too close to the object. The apparatus consists of three principal elements: the machine, which holds the work and lens; the lamp house; and the chart holder, which serves as a screen

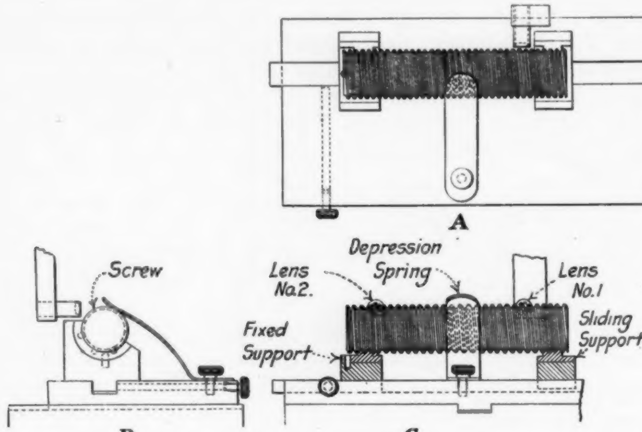

FIG. 4 WORK HOLDER OR CRADLE

on which the profile of the thread is projected. The chart holder slides on rails to and from the work in order to get the desired number of magnifications.

The general plan of operation starts with positioning the work and adjusting the light, work, lens and chart so that the image of a perfect screw thread will fall on the chart along certain

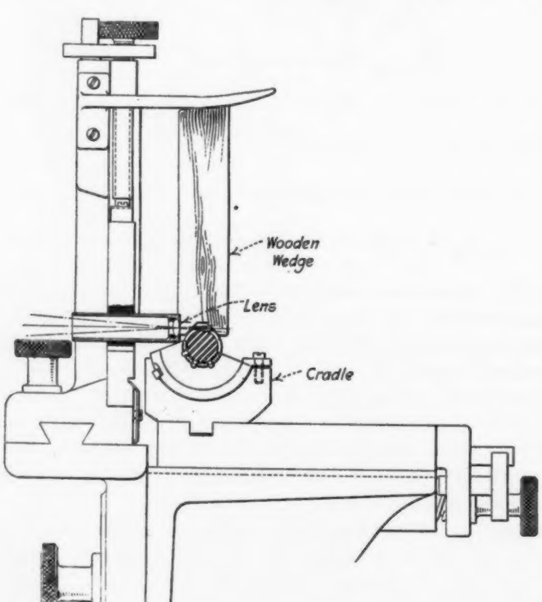

FIG. 4a METHOD OF HOLDING SCREW IN PLACE FOR TESTING

lines. When we have no sample of work on which the thread is known to be satisfactory, a standard screw-thread plug may be put in the work holder and used for setting the chart. After that the work may be placed in the machine, one piece after another, and instantly its shadow will reveal its diameter, lead error and profile. If these fall within a certain range of tolerance on the chart the work is acceptable.

The simplest method of screw inspection projects the profile of one thread on a chart that has a maximum and minimum boundary. The maximum boundary represents the outline of the thread of the hole into which the screw must fit and the minimum represents the smallest acceptable diameter.

Work Supports. It has been found necessary, in order to meet the usual run of work, to mount the screw in one or two cradles consisting of nearly a half-circle of a nut and embracing from one to three threads of the screw, according to the character of the work. With this form of mounting, it is possible, when projecting one of the threads to a tolerance chart, to get some indication of the roundness and roughness by merely turning the screw in its cradle.

Three views of supports of this type are shown in Fig. 4 at *A*, *B* and *C*. The threads of the supports are interrupted with notches so that turning the screw in the thread will tend to carry out chips or other foreign particles that otherwise might be lodged in the thread. A spring is indicated for the purpose of giving the screw a downward pressure to hold the work firmly into its seat when it is being rotated by hand, the extent of this contact and pressure being different for different grades of work. On a $^3/_4$-in. rough screw I have used a wooden wedge which slipped readily into place and enabled me to get uniform results, as shown in Fig. 4*a*.

If the thread to be tested is very short and on a shaft or bolt of considerable length, one of the cradles may be threaded to fit

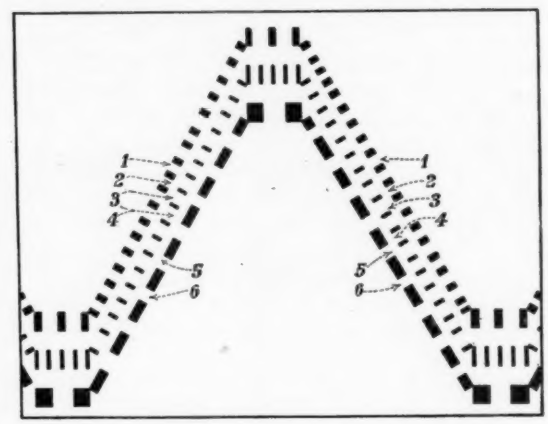

FIG. 5 TOLERANCE CHART (Greatly Reduced)

the screw, and the other may fit the cylindrical body of the bolt or shaft.

Although this method is subject to the uncertainties due to fine chips or other particles becoming lodged in the cradles, these things are more easily detected because the cradle is open and can be frequently inspected. Since a standard plug thread gage is the check on the adjustment of the projection apparatus, it may be dropped into the cradle at frequent intervals.

The object of using a cradle instead of single points, such as center points or single point contacts on the flanks or other parts of the screw, is to get a truer knowledge of the fit of the screw in the nut. The extent of area of contact of the cradle should be proportioned to the roughness of the work. Threads produced by the best methods of chasing on centers could use cradles with simple contact points.

Cradles are better than center points because 0.001 in. variation in diameter is fully shown on the chart, whereas by the use of center points with the projection of a single thread, 0.001 in. would show a variation on the chart of only half that amount, and although by confining the projection to one thread with parts of two valleys, a high magnification of 200 will give a displacement of 0.2 in. for each 0.001 in. of variation, the fact remains that it is desirable to get the best result with the minimum handicap. For instance, a small chip on a center point, when one is looking for an error of 0.0005 in., is more serious than if the chip were imbedded in a cradle.

The Condenser Lens may be a simple plano-convex, or it may be a combination of lenses to gather rays at a wide angle and condense them into a very small bundle of parallel rays. The essential thing, of course, is to have the rays travel in a parallel

direction when they reach the screw thread, striking the screw thread at the angle of the helix in order to present the sharpest profile for the lens.

In order to bring the screen as close as possible to the operator, I prefer to use a lens of very short focal length. For instance, for ½-in. size I am using 0.43 in. focal length, and this could be conveniently used for $\frac{5}{16}$-in., but for ¾-in. screws and larger the outside diameter of this lens would conflict with the sides of the screw, making it necessary to cut away part of each thread.

Tolerance Chart. The exact form of the chart will vary with different requirements, but I prefer a chart on which the boundaries indicated have stated gradations. For instance, for a screw thread of 10 pitch at 200 magnifications the outline of the thread form measures 20 in. between centers of crests of thread, and I produce a chart by drawing these forms in light pencil marks, in steps spaced at 0.8 in., which amounts to 0.004 in. variation of

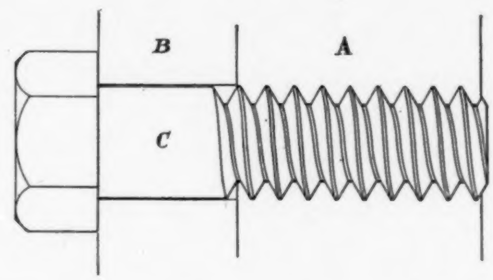

Fig. 6 Ideal Screw-Thread Fit

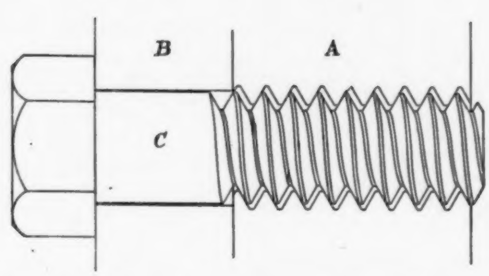

Fig. 7 Screw Smaller Than Threaded Hole

screw thread, for at 200 magnifications we have 0.2 in. per thousandth of an inch. Such a chart is shown in miniature in Fig. 5.

Inasmuch as it is not easy to locate the shadow in relation to straight lines, I use black dots having a vertical width of 0.8 in., which amounts to approximately a width of ⅜ in. on the flanks of the thread. These dots are made of different lengths so they may be readily recognized in the partial light of the projection room. The light of the projection room should be adjusted to see the black dots, even in the shadow, and yet not too light to dim the shadow.

By numbering the lines of the charts from 1 to 6, beginning at the upper and running to the lower side, we have means for recording, if necessary, the measurements of a screw. For this purpose we would set up the instrument with a standard plug gage or other perfect thread so that the shadow of this perfect thread would fall on line 5, and this would constitute the largest size that would be tolerated for free fits, the plug being the basic diameter.

Let us assume that the allowable tolerance at the pitch diameter of a 10-pitch screw is 0.008 in.; that is, that the screw may be up to the full basic standard line No. 5 or it may be 0.008 in. smaller, in which case the shadow should not proceed farther than line No. 3. Then by placing one piece of work after another in the holder, if the shadow falls within these boundaries of 3 to 5, we know its size is acceptable. If its shadow falls below line No. 5 toward No. 6, we know it is too large for that grade of fit.

Magnification of the Profile. The distance of the chart holder from the focal center of the lens must be as many times the distance from the focal center of the lens to the profile of the thread as the number of magnifications required. If the focal length of the lens were 1 in., the screen would have to stand away 200 in. to get a magnification of 200 diameters. With a 0.43-in. focal length we get 100 magnifications at 43 in. and 200 magnifications at 86 in. At a distance of 86 in. the shadow can be easily seen by the operator.

I am aware that in astronomy and other sciences using lenses, it is the novice that goes to the higher magnifications, and that the magnifications should not be greater than required, as the best result is obtained by the lowest magnification that will give the proper definition. And while I am aware that those who have been in this art for some time in testing gaging devices advise the low magnifications, it would seem to me that there may be a special reason for using large magnifications in this scheme for testing the work itself.

In this plan we have little or no occasion for projecting more

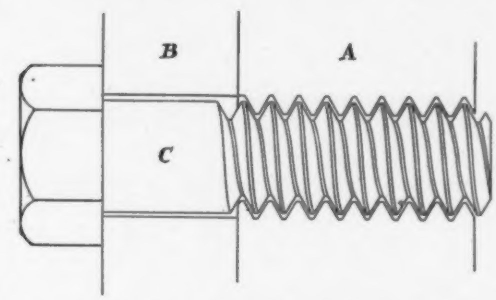

Fig. 7a Screw of Fig. 7 Placed in Central Position

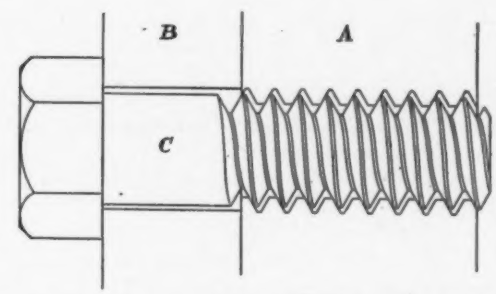

Fig. 8 Screw Standard but Threaded Hole Too Large

than a single profile, or if we project more than one of the threads, we superimpose the shadows so that the dimensions of the chart may be kept down to about 25 in. square for the run of work of standard threads up to 8 pitch with magnification up to 200.

Characteristics of Screw-Thread Fits

Figs. 6, 7, 7*a*, 8, 9 and 10 illustrate three elements of an ordinary screw-thread fastening. *A* and *B* are pieces to be forcibly held together by a cap screw or bolt *C*. A hole is drilled in *B* large enough for the whole of the screw to pass through it, excepting the head, and *A* has a tapped hole into which the screw is turned.

Fig. 6 represents an ideal screw-thread fit in which the flanks of the thread of the screw and the threaded hole closely fit the entire length of the screw.

Fig. 7 illustrates an extreme example in which the screw is smaller than the threaded hole so that the threads engage only three-quarters of the entire depth of the full engagement.

Fig. 8 illustrates a fit in which the thread diameters are the same when measured on the pitch line, but shows an example of a threaded hole in which the crests of the thread are not up to the full size owing to the hole having been drilled larger than the root diameter of the tap which produced it.

Fig. 9 shows a screw-thread fit in which the diameter of the screw is a trifle smaller than the diameter of the threaded hole, but the threads are not equally spaced so that it is just barely possible to turn the screw into the threaded hole, for it will be

seen that the flank of the thread at x and y bears in opposite directions, while the flanks of the thread at z stand clear.

Figs. 7 and 8 show the flanks of the thread properly engaged; that is, each thread bears its proportionate part of the load; whereas, in Fig. 9, the whole load comes first on a single thread at x. In practice, of course, ordinary differences that appear in lead result in the stress crushing down the first thread at x and gradually working back until they may be distributed the entire length, but not equally.

A reversal of the difference in lead, that is, making the thread of the bolt shorter than the thread in the threaded hole, puts the burden of the work first on the thread at y, and then gradually, either through crushing down of the first threads engaged or by stretching out of the length of the bolt, brings a distribution over the other threads.

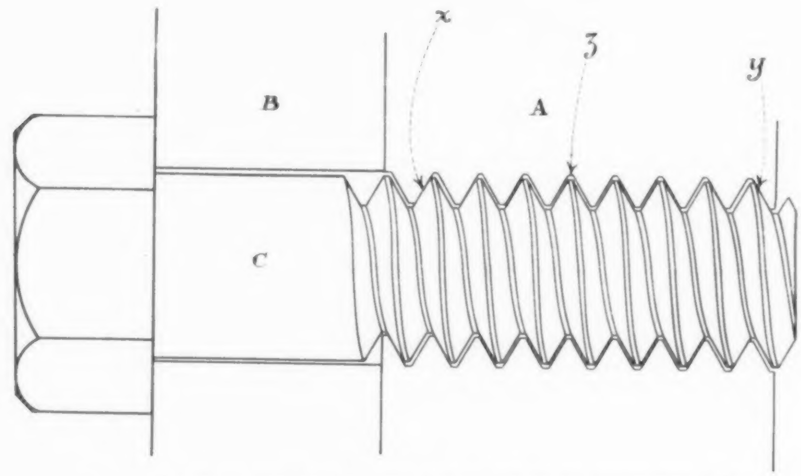

FIG. 9 LEAD OF SCREW GREATER THAN THAT OF THREADED HOLE

In making screw-thread fits we have not only the element of difference in diameter with true leads, but we have combinations of lead errors and diameter variations. It is obvious that with perfect lead the diameters must correspond to insure a depth of engagement that will prevent stripping under the working stress, and in addition to this, if the screw is one that is frequently adjusted and must have good wearing qualities, the depth of engagement must be great enough to provide ample wearing surface.

In addition to the foregoing elements, we have to consider the form of the thread. In Fig. 10 is shown a threaded hole in which the thread is of a blunter angle than the thread of the screw, and while this is not as serious a matter as may seem at first glance, for it has been found perfectly practicable for ordinary fastenings to use a 55-deg. Whitworth thread in a 60-deg. U. S. Standard, the fact remains that it is one of the elements that we must consider in determining the dependability of a screw-thread fastening, for the thread under stress must be squeezed into a shape that will produce a uniformity of contact over a fair amount of the flank surface. Our system of screw-thread gaging should take into consideration form as well as diameter and lead.

The foregoing figures illustrate the three elements, A, B and C, as they would appear when screwed together under a light stress. No attempt has been made to show the various degrees of change that take place under the enormous stresses of the work, although we are coming to a state of machine construction which demands a consideration of the form of thread when under stress. For the purpose of illustration and comparison of the optical gaging system with the tactile gaging system, that is, the system in which we see the condition of a screw as against the system in which we try to determine it by the sense of feeling, we will for the present ignore such stresses.

If we substitute Fig. 7a for Fig. 7, in which a small screw is shown in the threaded hole, but instead of being pulled to one side it stands clear, showing the amount of clearance there would be around each side of each thread—if we will take this for Fig. 7, we will find that the various fit conditions can be found by glancing at the thread at the end of the engagement; for instance, at point y or point x, as in Fig. 9.

Since the error in lead is equally divided between the opposite ends of the length of engagement, it is the end threads that tell us the story.

In the optical-projection method we so locate the screw before the lens that the shadow is thrown on the screen. A lateral displacement of the shadow will clearly indicate the lead error, and a vertical displacement a variation in diameter. The combination of the two will locate the shadow of a single profile on the chart in a way to indicate the condition at the end of a thread engagement of a given length. This tells the whole story of the resultant effect of diameter, lead and form of thread, for one of the boundaries of the chart may be considered as the interior profile of the threaded hole.

FEATURES DEVELOPED BY INSPECTION

The average run of work with the projection lantern will present some new thoughts to the inspector's mind. He will see that the lead is not uniform. In the length of a 3-in. screw the lead at one end of the screw may be shorter than at the other end. He will find that many screws are not round and some are very irregular and mountainous on the surface; not that these elements have been created by the projection apparatus, but merely that they have been brought clearly to view and should

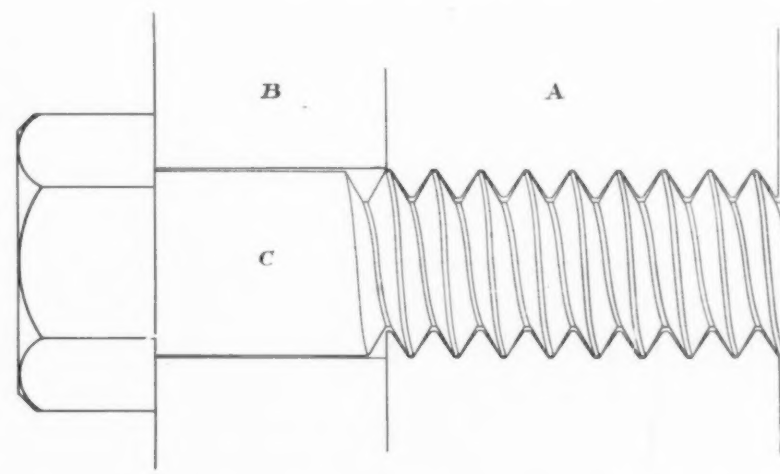

FIG. 10 THREADS OF SCREW OF DIFFERENT ANGLE FROM THREADS OF HOLE

be recognized by any system of gaging that has for its ultimate purpose determining the dependability of the screw.

Rotating the work in its holder brings out irregularities. If the screw is of good form, its shadow will remain stationary on the chart. If the thread is drunken, out of round or very irregular, the shadow will move. A ragged surface also appears in the unevenness of the line, and frequently the inspector is confronted with the necessity of determining what part of the line he is to designate as indicating the real working diameter of the screw.

It is not unusual to find one of the flanks of the thread, instead of presenting a straight profile, shows for instance a ridge near where the crest of the thread is rotated.

This condition has always existed in screw threads, and it is for us to recognize that the projection method merely shows how deceptive has been the gaging system which depended on the tactile sense or sense of "feel" of the gage.

In gaging this ridge would play an important part in elim-

inating shake, and yet the screw might be under size so far as its holding capacity is concerned.

When we see the displacement of the thread laterally, that is, if we assume that the profile of the thread on one side is on No. 4 boundary and the opposite side on No. 5, we will know that its lead is off to that extent, and that when turned into a nut the full length of the nut it will feel the same as a perfect thread. But as a matter of fact the slack will be taken up by opposite sides of the flank at opposite ends of the nut, while the middle may not be in contact.

Let us understand that line 5 represents the inside of the nut or at least the upper boundary for the screw. Now, in order to get a perfect indication of the fit of an inaccurate lead in a perfect nut, it is necessary for us to see that our holder which positions the work is adjusted in relation to the length of the engagement of the thread in the nut or in the threaded hole. For instance, if the lead is long or short we know that as it screws into the nut or threaded hole the difference in lead will cause the screw to fit in the nut as shown in Fig. 8, if the screw is longer than that of the nut, and on the opposite sides of the threads if the screw is shorter.

Now we must adjust our holding means so as to get a view of the thread at the end of the nut, which, of course, determines the closeness of its fit.

In Fig. 4, previously referred to, are three views, *A*, *B* and *C*, of a screw located in the cradle of a projection machine. In order to make the view projected on the chart duplicate the conditions in the nut, it is only necessary to see that the longitudinal distance between the distance of the fixed support and the lens (position No. 1) is equal to the length of engagement of the thread in the threaded hole. (If the screw were held on center points instead of on a cradle this fixed support would be one-half the length of engagement.)

It will be understood that the fixed support locates the screw in its longitudinal position as well as laterally; that the sliding support, although holding the screw in the right focal distance from the lens, adapts itself to the position of the thread which, if the lead is true, will be the same as a standard thread, and if the thread is short or long will move endwise without changing the vertical gage of the screw. The projection through the lens will then be displaced vertically if there is a difference in diameter, and displaced laterally if there is a change in the length of the lead.

The combination of these two when the distance to the fixed support is equal to the length of engagement gives a definite knowledge of the fit, and while it may be disturbing to know that the fit is not a fit in the true sense of the word, that it is a misfit is $99\frac{1}{2}$ per cent. of our work, it is best to know the truth if we are to make our machines dependable.

A lens located in position No. 2 can be adjusted to throw its shadow simultaneously with lens No. 1; or a shutter may be used to alternate these two. The object of lens No. 2 would be to check the parallelism of the screw. If the vertical position of the thread projected by lens No. 2 corresponded to the vertical position of the thread projected by lens No. 1, we would know that the thread was parallel.

If it were desirable to have this test for each screw that went through the instrument, its shadow could be so located as to fall two numbers lower than the shadow from lens No. 1, so that the range of its position would be from line 1 to line 3 on the chart, Fig. 5, while the range of the other position would be from 3 to 5, and the uniformity of the average distance between these would constitute an indication of parallelism.

The essential thing in gaging the rougher screws is to see that the screw is held down in its supports with sufficient pressure to insure good contact.

MARINE PRACTICE IN VALVES AND FITTINGS

A Paper in Which the Author Suggests That Certain Features of Central-Station Practice Be Extended to Marine Practice

By A. G. CHRISTIE,[1] BALTIMORE, MD.

This paper consists of a series of comments on certain marine practices in regard to valves and piping, from the viewpoint of a central-station man. In recent years there has been a wide use on shipboard of such types of central-station equipment as water-tube boilers and superheaters, geared turbine units, high-vacuum condensers with rotary and ejector air pumps, and centrifugal boiler-feed pumps. Marine practice, however, has lagged behind central-station practice because of the well-known conservation of ship owners.

It has taken this world war to accelerate the adaptation to ships of much of the standard central-station apparatus. Certain factors are now at work which have considerable influence on present marine practice in valves and piping. Of these the greatest is the fabricated-ship yard. In the old-style yard the shops would make up any or or all of their fittings or valves to their special designs, each yard having its own designs which differed from those of other yards. The result of this was a constantly increasing number of special valves and types in each shipyard, with the consequent increase in cost of ship construction. The fabricated-ship yard, however, was forced to buy in the open market and in order to get deliveries had to purchase standard types and sizes. This made engineers study their valves and endeavor to standardize them. In one yard it was thus found possible to reduce the number of types by 20 per cent. It is entirely practicable to use manufacturers' standard stock patterns for nearly all valves, fittings and auxiliary equipment. This standardization, with consequent reduced costs, will be one of the deciding factors in maintaining our shipbuilding supremacy after the war. Standard valves require fewer repair parts and these are more easily procurable for renewal. Decided advantages may be gained by still further extending present standardization.

Piping

A factor which has influenced piping practice is the availability of materials. For instance, copper piping in sizes suitable for steam mains has become so scarce that open-hearth lap-welded steel pipe is often adopted in its place. The use of copper piping has long been standard practice on shipboard. This piping has considerable flexibility and generally stands up well in marine service, but it is not well adapted to superheat conditions. Steel pipe is much cheaper than copper pipe, is more readily available, and is well adapted to any pressures and temperatures that may be encountered. Some engineers fear that it may lack the flexibility of copper pipe, although steel piping in central stations is frequently subjected to strains from contraction and expansion as severe as one finds on board ship; and furthermore is frequently subjected to severe stresses due to unbalanced turbine rotors and other harmonic vibrations. The substitution of steel for copper piping is merely a matter of marine engineers becoming accustomed to designing and installing their steam systems in accordance with steel-pipe standards. In other words, it is dependent on their ability to break away from traditional practice.

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Presented at a meeting of the Baltimore Section of The American Society of Mechanical Engineers, November 20, 1918.

Steel pipe, however, does not withstand corrosion as well as copper pipe. Galvanized steel pipe has been tried for this purpose. In time the galvanized material flakes off under the influence of heat and causes trouble. Repeated painting of such steel pipe seems to be the best protection.

Galvanized pipe should be used on sanitary systems and bilge and ballast piping. However, no advantage is gained by galvanizing the cast-iron fittings of these systems. It is also questionable whether fuel-oil piping in oil-burning ships needs to be galvanized at all.

The problem of caring for expansion has made many engineers prefer copper to steel in piping. In general, long-radius bends provide the best means for taking care of expansion difficulties. Space is limited in vessels, but much may be accomplished in the way of providing such bends if a little study is given to the subject. Some have questioned the flexibility of bends of extra heavy steel pipe. Crane Company's tables indicate that there is usually ample flexibility to care for any lengths that are generally used on shipboard.

Pipe Flanges

Expanded flanges of the Lovekin or similar types are almost universal with copper pipe. Lovekin flanges are used to some extent with steel pipe, but welded or screwed joints are more common.

Land practice in piping seems to have advanced far beyond marine practice in the use of the Van Stone joint. It is said that the first installation of this type of flange on shipboard many years ago was not a success. Apparently this has condemned this excellent joint ever since. Although giving excellent service under most exacting conditions on land, it is taboo at sea. The welded type of Van Stone joint now in use in central stations has apparently never been tried out at sea.

Fittings

With superheated steam, and in general with all steam of over 150 lb. pressure, it is advisable to use cast-steel fittings on the steam lines. For pressures of 100 to 160 lb., extra heavy cast-iron or, better still, semi-steel fittings may be used. For pressures below 100 lb. cast-iron or malleable fittings of standard pattern may be used. In screwed fittings the collar over the threaded portion should be sufficiently heavy to prevent distortion when screwing up with pipe wrenches. Malleable iron is preferred by many on account of its lesser liability to rupture under stress. However, such fittings are generally lighter than cast-iron and are sometimes deformed in screwing up.

In central stations it is very common practice to find branch outlets welded to the main pipe and in general these welded pipes have given very excellent service. This practice is apparently very little used in marine work, although it would make a weight-saving construction by doing away with many cast-iron special fittings now used.

Valves

Standard types of valves must be bought if one is to place orders in the open market under present conditions. Steel valves are used for superheat. Some shipbuilders even specify steel valves for all boiler pressures of 200 lb. or greater. If superheat is not used the valves may be extra heavy, of cast iron or semi-steel. These materials are also used for auxiliary steam lines. Bronze valves are sometimes employed in the smaller sizes, but these are very much more expensive than the extra heavy cast-iron valves and in sizes of 2½ in. and over have no advantage over them except in lightness of weight.

Valves 2½ in. and above must have bolted bonnets to comply with the U. S. Steamboat Inspection Rules. The marine or cross-head type of yoke is much superior to the standard cast yoke for ship purposes. It weighs less and is generally stronger and more readily repaired. It costs very little more than the cast yoke, but is not "standard" with many builders. The latter yoke can be safely used for all low-pressure services.

It is customary on board ship to use the screwed-union bonnet on 2-in. and smaller valves. This type of valve is generally more expensive than the ordinary bonnet type, but has many points of superiority such as its regrinding facilities, longer life and less liability to damage when dismantling. Valve manufacturers generally make the screwed-union bonnet valves in two weights, one to withstand 200 lb. pressure, the other for 350 lb. pressure. It is therefore necessary to use the 200-lb. valves for many low-pressure services. This has considerable advantages, for fewer types of valves need be bought and their interchangeability is increased.

Cast-iron or semi-steel valves for marine service are usually required to have a solid bronze disk with bronze seat. The stem may be of rolled phosphor bronze, rolled naval brass or manganese bronze. Gland studs and nuts should also be of bronze. Steel valves for superheat generally have monel-metal disks and seats with bronze or nickel-plated steel stems. The bronze generally used for valve bodies, disks, seats, glands, etc., is the navy composition "M" consisting of copper 87 per cent, zinc 7 per cent, tin 6 per cent, and may contain lead up to 2 per cent in place of part of the copper. The lead content must be kept as low as possible on account of the action of the salt water.

It is the practice of many marine designers to specify a flange corresponding to extra heavy standard on the sea side of all sea valves, sometimes even when these are connected to the sea chests. Usually the valve is in all other respects of standard weight. This extra heavy flange adds nothing to the strength of the valve, for its weakest point is in the neck behind this flange, which is sometimes but not always made extra heavy. Some maintain that the extra heavy flange is needed to stiffen the ship plate. This same result is secured elsewhere by adding a reinforcing ring to the ship's plates. This type of valve is a "special" to the manufacturers and hence is high-priced and often difficult to obtain on reasonable deliveries.

Shipbuilders generally have endeavored to use A.S.M.E. standards for flanges and drilling. However, some criticisms have been heard. For instance, many marine engineers do not favor the raised faces on extra heavy flanges. They prefer flat faces. The flat faces are also favored for bolting to bulkheads and to other ship plates.

The bolting specified for certain sizes in the A.S.M.E. standards has not been satisfactory to many marine designers. For instance, in the 3-in. and 3½-in. standard-weight flanges the A.S.M.E. standard calls for four holes, while many marine designers use six holes. Also, in the 2-in. and 2½-in. extra heavy flanges the marine engineers frequently use six holes where the A.S.M.E. standards specify four. The A.S.M.E. standards increase the holes at one jump from four to eight. There seems considerable justification for the use of the six-hole flange.

One cannot help commenting on the small use made of gate valves on ships. These are especially adapted to fuel-oil service and could be used to advantage on many water lines just as in land practice. A greater use of gate valves would relieve the existing valve shortage to an appreciable extent and also reduce friction. Reducing valves, relief valves, separators, traps, injectors, etc., can all be supplied equally well from the manufacturer's standard stock patterns made for central-station work as from special marine designs.

It is rather difficult to understand the basis for marine practice in heating systems. Live steam is usually passed through a reducing valve and supplied to the heating system at 20 to 30 lb. pressure. The advantages of exhaust steam for heating and of steam bled from the main turbine do not seem to be fully appreciated in marine practice. Such uses of steam would make operation less simple, but would result in a thermodynamic gain, especially in passenger ships and troop transports.

Inspectors are frequently required to apply tests to valves. In general, such tests are specified in Lloyds and U. S. Steamboat Inspection Rules. A satisfactory standard for inspectors is to test all high-pressure steam valves under hydraulic pressure to three times their working pressure and to test all other valves to twice the working pressure corresponding to their weight or classification.

THE CHEMICAL AND PHYSICAL CONTROL OF BOILER OPERATION

Including the Application of Simple Formulae for Estimating the Heat-Loss Items, etc.

By E. A. UEHLING,[1] PASSAIC, N. J.

THE best method for attaining the conservation of fuel has not been definitely outlined by engineers. There is, therefore, room for discussion, and it is intended to treat the subject in the present paper from the chemical and physical aspects of combustion.

Before intelligent steps can be taken to bring a given boiler plant to its maximum efficiency, it is necessary to know with what efficiency the plant is working. Scientific refinement is not necessary in every-day practice, but *scientific reasoning must be applied*, and the data upon which reasoning can be based must be observed and, wherever possible, autographically recorded.

Methods of Controlling Boiler-Plant Operation

The economical status of a boiler plant can be ascertained by either of the two distinct methods, viz.:

a The mechanical method, based on the heat utilized

b The chemical and physical method, based on the heat wasted.

The mechanical method relies on the readings of the coal weigher and the water meter or steam-flow meter. If the heat value of the fuel is known, the data obtained by these appurtenances enable one to calculate roughly what percentage of the heat in the coal fired is utilized in making steam. For obvious reason the results cannot be calculated oftener than once a day and generally once a week is considered sufficient for a control over the operation of the boiler plant. Aside from the lateness in obtaining the desired information, this method suffers in accuracy and reliability as a control from the following errors and shortcomings:

a The coal weigher cannot discriminate between coal and ash and moisture, and since these constituents are never constant and frequently vary five per cent or more in successive shipments, and since the heat value of the fuel depends on its purity, the calculated results will be that much in error

b The water passed through the meter is not all evaporated. An appreciable amount may be carried over with the steam, more may be lost through leaky blow-off cocks, and considerable is wasted by blowing off the boilers, which is not only not accounted for but actually appears on the credit side

c The steam may be superheated

d The feedwater temperature may vary appreciably.

Thus we see that a water meter and coal weigher can give only a rough, wholesale control, unless supplemented by scientific instruments and observations. The mechanical control has another and even more serious shortcoming in that it gives absolutely no clue as to why the plant as a whole is operating more or less wastefully.

The wholesale chemical and physical method of control is based on the readings of a CO_2 meter and pyrometer inserted in the main gas flue at or near the chimney. This method suffers from the following deficiencies and inaccuracies:

a The indicated and calculated results are qualitative

b The results do not represent all the heat wasted

c From the CO_2 determination in the chimney gas one is unable to discriminate between excess air through the fire and that leaking through boiler walls, as well as that leaking into the gas flue between the boilers and the point where the sampling tube must be inserted to get the gas from all the boilers. Air entering beyond the boilers does not militate against efficiency except as it may overburden the chimney and reduce the draft below that required for efficient combustion.

The wholesale chemical and physical method has the following advantages over the mechanical method:

a It can be more easily and cheaply installed

b The records show up the collective operation of the boilers continuously instead of only at the end of longer or shorter periods; one day at best

c It shows up the combustion and absorption efficiency factors separately so that the proper steps to improve the efficiency of the plant can be promptly and intelligently taken

d The value of its records is not affected by a variation in ash or moisture content of coal burned. Nor is the record affected by the waste of feedwater nor the variation in its temperature.

From the preceding consideration it becomes evident that both wholesale methods are equally handicapped as an aid to improve boiler efficiency, and that in order to obtain maximum collective boiler efficiency each boiler must be diagnosed individually. To be under proper economic control, both its combustion and absorption efficiencies must be under constant observation. Maximum boiler efficiency cannot be maintained without *knowing what every boiler is doing all the time*. To this every combustion and boiler expert will agree; but opinions will no doubt differ as to the best means for effecting this constant observation. It would appear obvious that the most direct way is the best way. Combustion is a chemical phenomenon, and should therefore be most effectively controlled by chemical means. Absorption is a physical phenomenon and is best controlled by physical means. The two principal instruments of observation are the CO_2 meter, a chemical instrument, and the pyrometer, which is a physical instrument. As a necessary auxiliary the double differential draft gage is required. Boiler draft and furnace draft are essential elements in the proper control of combustion and should be observed separately.

The slogan for the boiler room should be: *Watch your results and change your adjustments to keep the results right.* There is no such thing as a fixed adjustment in the operation of a boiler. The rate of combustion must be changed to keep the steam pressure right, the draft must be changed to keep the rate of combustion right, and the thickness of fire must be changed to keep the efficiency of combustion (per cent of CO_2) right. As the fuel and ash bed thickens, a stronger draft is necessary to keep the required rate of combustion, and there are numerous minor variables which require changes in the draft adjustments if combustion efficiency and the required boiler capacity are to be maintained, i.e., maximum CO_2 and a uniform steam pressure. To insure these results CO_2 as well as boiler and furnace draft indicators must be placed at or near the boiler front within easy view of the fireman and in close proximity to the draft-regulating wheel or lever.

Information Afforded by Recording-Instrument Charts

The three autographic records, namely, those of CO_2, temperature of the escaping gas and the boiler draft, preferably on one chart, give the engineer in charge the following information at a glance:

a Whether normal combustion efficiency has been maintained; and if not, the precise time when it became abnormal and how long it remained so. This enables him to inquire into the cause, with the confidence born of knowledge, and to apply the proper correction. The continuous record further reveals in hand-fired boilers how often the fires were replenished, how long the fire doors were left open, when the fires were cleaned and how long it took to clean them. In stoker-fired boilers changes in handling the fire are similarly revealed

b The temperature record shows whether the absorption efficiency has continued normal; if not, the variation may be due to necessary variations in the rate of driving, and if so this will be revealed by the record of the boiler draft, which is

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an index to the rate of driving. Or it may be due to a breaking-down of the baffling, which is also instantly revealed by the boiler draft. The mucking-up of the heating surface is indicated by a gradual increase in the temperature of the escaping gases

c The record of the boiler draft, in addition to its contributing value to the pyrometer record, becomes in combination with the per cent of CO_2 a very good index to the rate of combustion, as the writer will endeavor to show later.

EXAMPLES OF APPLICATION OF INFORMATION GIVEN BY CHARTS TO CONTROL OF FIRING

Fig. 1 illustrates sections of recording-instrument charts showing various relations of these three records to each other. The CO_2 records shown in Secs. 1 and 2 are facsimile samples of records from a boiler of the Manning type burning No. 1 buckwheat coal. Sec. 1, made when the recorder was first installed, shows that the firing was irregular and that the coal bed was kept too thin, through which holes quickly developed. The average CO_2 was scant 8 per cent. The reason for the low CO_2 being thus clearly revealed, the proper remedy at once suggested itself. The fireman was instructed to carry a little heavier fire and watch the CO_2 indicator, with the result shown in Sec. 2, which is a sample record for the same boiler after the fireman had been instructed and had learned to be guided by the CO_2 indicator in adjusting the thickness of the fire to the draft necessary to maintain the required steam pressure. So guided he had no difficulty in keeping the CO_2 at an average of about 12 per cent. Having the three principal records on the same chart their relation to one another is readily perceived, and it will be seen at a glance that the boiler draft is about 0.80 in. higher under the conditions represented by Sec. 1 than those by Sec. 2, also that the temperature shown in Sec. 1 is about 25 deg. higher than in Sec. 2.

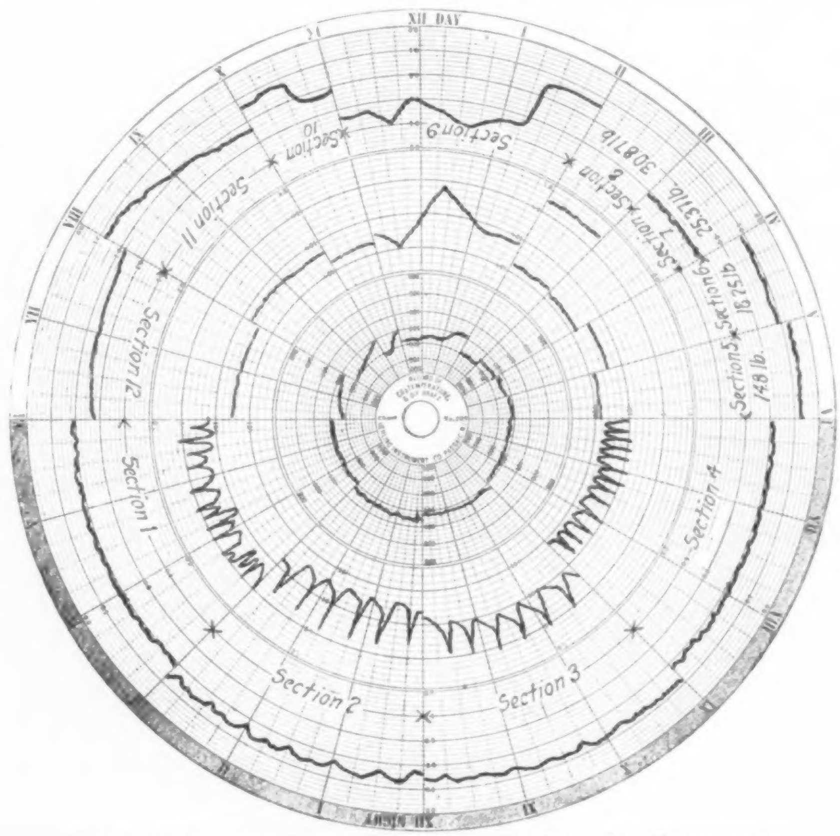


FIG. 1 SECTIONS OF CHARTS RECORDING CO_2, STACK-GAS TEMPERATURE AND BOILER DRAFT

It will be noticed that the gases left the boiler at a temperature 25 deg. higher when containing 8 per cent of CO_2 than when they contained 12 per cent, which shows that absorption efficiency increases with combustion efficiency.

It will further be noticed that the boiler draft is about 0.12 in. with 12 per cent of CO_2 and fully 0.20 in. when only 8 per cent of CO_2 is present, which is due to the greater volume of gas per pound of carbon consumed.

Now since the boiler draft is an approximate index to the volume of gas produced per pound of carbon burned and CO_2 is a true index of the weight of carbon contained in this volume of gas, it follows that if we multiply the boiler draft by the percentage of CO_2, the product will be an approximate index to the rate of combustion. We therefore find that the indices to the rate of combustion under the conditions which are recorded in Secs. 1 and 2 were respectively $8 \times 0.20 = 1.60$, and $12 \times 0.12 = 1.44$.

This means that it was necessary to burn about $[(1.60 - 1.44)/1.44] \times 100 = 11$ per cent more coal to keep up the steam with 8 per cent of CO_2 than with 12 per cent, which corresponds very well with the improved results attained in the plant in which the records thus analyzed were produced.

Secs. 3 and 4 of Fig. 1 show records representing a water-tube boiler burning bituminous coal. Sec. 3 illustrates conditions before, and Sec. 4, after, control by aid of CO_2. A glance at the CO_2 record will show that the fires carried were too thick. The low percentage of CO_2 (about 8.75 per cent) was due principally to air infiltration, but to a considerable degree also to uneven firing producing high CO with low CO_2. Stopping up the air leaks and modifying the method of firing as illustrated by the record and using the CO_2 indicator as a guide, the fireman had no difficulty in maintaining an average of over 13 per cent of CO_2 with practically no CO.

Contrary to what was seen in Secs. 1 and 2 of the chart, both the temperature of the escaping gases and the boiler draft were higher when the conditions had been changed so as to result in the higher percentage of CO_2. This may at first seem contradictory; but a little study reveals the fact that both the boiler draft and the temperature of the escaping gases were rendered abnormally low by the flow of air (counter draft) entering through the leaky setting. It is therefore necessary to make sure that the setting is made tight before these two factors can be relied upon as indices, respectively, of absorption efficiency and rate of combustion. Furthermore, a low stack temperature cannot be relied on as an index to the former unless the gases contain a high percentage of CO_2.

In Secs. 5, 6, 7 and 8 of the chart are recorded the averages of four 24-hour tests of a large water-tube boiler burning bituminous coal fired by Roney stokers. The coal was burned at four different rates of combustion; viz., 16.7, 18.25, 25.3 and 30.8 lb. per sq. ft. of grate surface per hour. The CO_2 averaged 14.68, 13.05, 14.28 and 14.69 per cent; the boiler draft was 0.08, 0.12, 0.31 and 0.61 in. of water, and the temperature of the escaping gases averaged 483, 542, 662 and 636 deg. fahr., respectively. The efficiency attained was respectively 81.15, 77.45, 75.28 and 76.73 per cent.

These four tests demonstrate that the percentage of CO_2 can be maintained at its maximum irrespective of the rate of driving without increasing the percentage of CO, provided there is ample space for combustion. *A large combustion chamber is a most vital factor in securing combustion efficiency.*

Sec. 9 of the chart illustrates the relation the three records will take to each other if the demand for steam suddenly increases and the draft is adjusted to increase the rate of combustion to meet this increased demand, but the stoker is not speeded up sufficiently to supply the coal required. The flue-gas temperature will at once go up in response to the increased rate of combustion. The CO_2 will soon begin to drop, and if there is no CO_2 indicator

to show what is happening it will continue to drop until the fireman discovers that the grate is getting bare and the stoker speed must be increased. He does so, but gives it a little too much speed and the CO_2 goes above the safe limit. If he is a good fireman he will no doubt discover that also and finally get the right adjustment. Meanwhile considerable fuel has been wasted, first by excess air and then by incomplete combustion. With a CO_2 indicator to guide him this would not have happened.

Sec. 10 illustrates how the boiler-draft and pyrometer records will at once reveal the sudden breaking-down of a section of baffling. Sec. 11 shows how the average temperature and boiler draft would be affected if the baffling disintegrated gradually, and Sec. 12 indicates how the records would be likely to change if the boiler tubes were allowed to muck up gradually. These suppostitious cases are given to show how the boiler draft and exit temperatures are affected by the same cause. Neither can be correctly interpreted without the other. Within practical limits of driving the maximum percentage of CO_2 can and should be maintained, whereas both the boiler draft and the exit temperature increase with the rate of driving. The exit gas temperatures vary from the normal from four distinct causes:

a Rate of driving
b Defective baffling
c Dirty heating surface
d Air infiltration.

The record of the boiler draft at once reveals the true cause; the pyrometer simply reveals the fact. Low exit gas temperature is generally taken to indicate absorption efficiency and the CO_2 record shows whether it is or not.

It thus appears that the three records, viz., percentage of CO_2, temperature of the escaping gases, and the boiler draft, autographically recorded, preferably on the same chart, reveal in detail all the facts necessary for effective control of the boiler operation. They give a continuous up-to-the minute history of the essential factors on which economic operation depends, and provide a ready means for interpreting the causes of irregularities and for applying the proper remedy promptly and intelligently. The three records being on the same chart, they can be quickly integrated by a polar planimeter and averaged, and thus form the best basis for a bonus system.

In addition to the three recording instruments, an Orsat apparatus is also essential—

a For determining the maximum per cent of CO_2 that can be carried without danger of an appreciable loss because of incomplete combustion
b To diagnose the boilers for air infiltration at regular intervals, or in between, if deemed necessary, and
c To check up the CO_2 meters when their indications give cause for suspecting their accuracy.

An Orsat is by itself quite inadequate as a control for the firing operations of a boiler plant, even when supplemented by sampling tanks, which combination, although better than nothing, cannot be considered more than a makeshift.

FORMULÆ FOR CALCULATING HEAT LOSSES IN CHIMNEY GASES

It will now be shown how the information given by recording-instrument charts may be applied in computing the heat losses in detail. The following simple formulæ,[1] developed by the author, are based on a weight of fuel containing 1 lb. of carbon instead of on 1 lb. of fuel or combustible:

$$A_e = \frac{A_c \times 21}{P} - A_c \quad\ldots\ldots[1]$$

$$A_t = \frac{A_c \times 21}{P} = \frac{11.6 \times 21}{P} = \frac{243.6}{P} \quad\ldots\ldots[2]$$

$$L_d = (1 + A_t) S \times (T - t) \quad\ldots\ldots[3]$$

$$L_d = \left(0.24 + \frac{58.46}{P}\right) \times (T - t) \quad\ldots\ldots[4]$$

$$A_e = \frac{A_c \times 21}{P} - (A_c + N_h \times H_a) \quad\ldots\ldots[5]$$

[1] The derivations of these formulae are presented in the complete paper.

$$L_d = \left(1 + \frac{58 + 46}{P}\right) \times (T - t) \quad\ldots\ldots[6]$$

$$L_c = 10{,}150 \times \frac{P_c}{P + P_c} \quad\ldots\ldots[7]$$

$$L_h = (8734 \times H_a) + (4.3 \times H_a)(T - t) \quad\ldots\ldots[8]$$

$$L_v = A_c\left(\frac{117}{P} + 3.8\, H_a\right) \times (T - t) \quad\ldots\ldots[9]$$

$$P_e = \frac{2100}{P(1 + 3\, H_a)} - \frac{(1 + 238\, H_a)}{1 + 3\, H_a} \quad\ldots\ldots[10]$$

$$P_o = 21 - (1 + 2.38\, H_a) \times P \quad\ldots\ldots[11]$$

$$P_m = \frac{A_c \times 21}{A_c + N_h \times H_a} = \frac{152 \times 21}{152 + 361\, H_a} = \frac{21}{1 + 2.38\, H_a} \quad\ldots[12]$$

Where

O = weight of oxygen per lb. of carbon in the fuel
H_t = weight of hydrogen per lb. of carbon in the fuel
$H_a = H_t - \frac{O}{8}$ = weight of available hydrogen per lb. of carbon in the fuel
A_c = weight of air required to burn 1 lb. of carbon
A_t = total weight of air supplied
A_e = weight of excess air supplied
N_h = weight of nitrogen in weight of air required to burn 1 lb. of hydrogen
A_v = weight of water vapor per lb. of air supplied per lb. of carbon burned
P = per cent of CO_2 in flue gas
P_c = per cent of CO in flue gas
P_e = per cent of excess air in flue gas
P_o = per cent of free oxygen in flue gas
P_m = maximum theoretical per cent of CO_2 obtainable from any given fuel
S = 0.24 = specific heat of dry gases
T = temperature of gases on leaving the boilers, deg. fahr.
t = temperatures of air supplied for combustion, deg. fahr.
L_d = B.t.u. carried off by dry gas per lb. of carbon burned
L_c = heat value of CO contained in gas per lb. of carbon burned
L_h = B.t.u. carried off by H_2O produced by the combustion of the available hydrogen per lb. of carbon burned
L_v = B.t.u. carried off by water vapor in the air supplied to burn 1 lb. of carbon

Air contains	Per cent by weight	Per cent by volume
Oxygen	23	21
Nitrogen	77	79

One cubic foot of air at 62 deg. fahr. weighs 0.0761 lb.
One cubic foot of nitrogen at 62 deg. fahr. weighs 0.0742 lb.

APPLICATION OF FORMULÆ TO DATA DERIVED FROM AUTOGRAPHIC RECORDS OF CO_2

The usefulness and reliability of these formulæ are best shown by applying them to the data observed in a few authoritative boiler tests and comparing the results.

Tests A and B, Table 1, were made on a large boiler of the Stirling type rated at 2400 hp., equipped with forced draft and Roney stokers; the fuel was Pittsburgh coal. Tests C and D were made on a 210-hp. Heine boiler, hand-fired. The fuel was No. 1 Arkansas briquets in test C, and Illinois No. 3 coal in test D.

Dividing the weight of all the constituents of the coal by the weight of carbon per pound of fuel in order to reduce them to the carbon unit basis of 1 lb. gives the following values:

C	H	O	Ash	Moisture	B.t.u.
1.0	0.0683	0.1068	0.0925	0.023	17 984

The available hydrogen per pound of carbon is

$$0.0683 - \frac{0.1068}{8} = 0.055 \text{ lb.} = H_a$$

TABLE 1 DATA AND RESULTS OBTAINED IN FOUR AUTHORITATIVE BOILER TESTS

Test Data	Test A	Test B	Test C	Test D
Analysis of Coal:				
Carbon, per cent	76.87		79.76	71.52
Hydrogen, per cent	5.31		3.91	4.53
Oxygen, per cent	8.32		2.70	8.18
Nitrogen, per cent	1.11		1.58	1.52
Sulphur, per cent	1.20		1.75	1.64
Ash, per cent	7.19		11.04	15.70
Moisture, per cent	1.80	....	0.94	8.51
B.t.u.	13,826	....	13,885	12,857
Analysis of Gas:				
CO_2, per cent	14.90	14.23	9.36	7.10
CO_2, per cent	0.23	0.36	0.00	0.04
O_2, per cent	3.40	4.30	10.57	13.40
Temperature of gas, T, deg. fahr.	483	670	624	635
Temperature of atmosphere, t, deg. fahr.	73	81	87	62
Total effective draft, in. of water	0.26	0.57	0.35	0.58
Furnace draft, in. of water	0.14	0.22	0.15	0.21
Boiler draft, in. of water	0.12	0.35	0.20	0.37
Humidity in air, per cent saturation	62.4	64.5	......	
Carbon in ash, per cent	31.6	38.0	23.02	33.73
Duration of test, hours	24	30	10	10
Rated h.p. of boilers	2400	2400	210	210
Test Results as Reported				
Efficiency, per cent	81.15	75.78	67.33	64.20
Heat loss up chimney, per cent	15.15	19.76	23.12	32.60
Heat loss in ash, per cent	2.29	2.13	....	
Heat loss by radiation, etc., per cent	1.51	2.33	9.55	3.74
Total	100.00	100.00	100.00	100.00
Water evaporated per lb. of coal, lb.	9.95	9.01	7.9	6.2
Coal burned per hr. per sq. ft. of grate, lb.	14.81	25.97	18.74	21.23
Horsepower developed	2225	3606	206	201
Driving, per cent of rating	94	152	98.3	95.5

The water of hydration per pound of carbon is

$$0.1068 + \frac{0.1068}{8} = 0.12 \text{ lb.} = W_{hy}$$

From the data obtained in Test A, the heat carried up the chimney by the dry gases, according to Formula [3], is

$$L_d = \left(0.24 + \frac{58.46}{P}\right) \times (T - t)$$

Substituting the values of P, T and t,

$$L_d = \left(0.24 + \frac{58.46}{14.91}\right) \times (483 - 73) = 1706 \text{ B.t.u.}$$

Also, the heat value of the CO_2 contained in the gas, according to Formula [7], is

$$L_c = 10{,}150 \times \frac{P_c}{P + P_c}$$

Substituting the values of P_c and P,

$$L_c = 10{,}150 \times \frac{0.023}{14.9 + 0.23} = 10{,}150 \times 0.0151 = 153 \text{ B.t.u.}$$

From Formula [8] the heat carried off by the H_2O from the combustion of the available hydrogen, is

$$L_h = 8734\, H_a + 4.32\, H_a (T - t)$$

Substituting the values of H_a, T, and t,

$$L_h = 8734 \times 0.055 + (4.32 \times 0.055 \times 410) = 578 \text{ B.t.u.}$$

Also, the heat absorbed by the humidity in the air, according to Formula [9], is

$$L_v = A_v\left(\frac{117}{P} + 3.8\, H_a\right) \times (T - t)$$

The average temperature of the air during the test was 73 deg. and the average humidity 62.4 per cent saturation. At this temperature and saturation the water vapor carried into the furnace is 0.0106 lb. per lb. of air supplied $= A_v$. Substituting this value and the values of H_a, P and $(T - t)$ in Formula [9],

$$L_v = 0.0106\left(\frac{117}{14.90} + 3.8 \times 0.055\right) \times 410 = 34 \text{ B.t.u.}$$

The heat carried by the water of hydration equals

$$L_w = W_{hy} \times (0.48\, T + 1080 - t)$$

Substituting the values of W_{hy}, T and t,

$$L_w = 0.12(0.48 \times 483 + 1080 - 73) = 149 \text{ B.t.u.}$$

Substituting the value of W_m for W_{hy}, where W_m is the weight of moisture per lb. of carbon, the loss due to the moisture in the coal is

$$L_w = 0.023(0.48 - T \times 483 + 1080 - 73) = 28 \text{ B.t.u.}$$

The foregoing comprise all the items of heat wasted up the chimney with the exception of that contained in the hydrocarbons, if any, and in the soot and ash passing off with the gases, and may be enumerated as follows:

Heat-Loss Items Up the Chimney

	B.t.u.
a Heat carried to waste by the dry gases	1706
b Heat value of CO	153
c Heat carried to waste by the H_2O from the combustion of the available hydrogen	578
d Heat loss due to the humidity in air	34
e Heat carried to waste by the water of hydration	149
f Heat carried to waste by the moisture in the coal	28
g Total heat in H_2O in gases	789
h Total heat in flue gas per lb. of carbon burned (items *a*, *b* and *g*)	2648

Hence $\frac{2648 \times 100}{17984} = 14.72$ per cent of the heat of the coal remained in the gases as they left the boiler.

The ash contained 31.6 per cent of carbon and since the coal contained 0.0925 lb. of ash per lb. of carbon, the loss due to the heat value of the combustible in the ash is

$$0.316 \times 0.0925 \times 14{,}600 = 427 \text{ B.t.u.}$$

which represents

$$\frac{427 \times 100}{17{,}984} = 2.38 \text{ per cent of the heat in the coal.}$$

The total heat loss accounted for by the preceding calculations is therefore

	Per Cent
Heat absorbed by boiler	81.10
Heat loss up the chimney	14.72
Heat loss through the grate	2.38
Heat loss from radiation, etc	1.80
Total	100.00

The heat-loss items in Test A were reported as follows:

	Per Cent
Moisture in coal	0.16
Hydrogen in coal	4.29
Heat to chimney	9.11
Moisture in air	0.20
Carbon monoxide	1.29
Carbon in ash	2.29
Total losses accounted for	17.34
Absorbed by boiler	81.15
Radiation, etc.	1.51
Total	100.00

Applying the same formulæ to the observed data of Tests B, C and D, the results given in Table 2 are obtained.

Combustion efficiency in the operation of a boiler means only that all the combustible in the fuel must be completely oxidized, but that it must be oxidized in a manner that the maximum amount of the heat liberated becomes available to the boiler. Theoretically, all the heat liberated by combustion is available to the boiler except that contained in the gases below the temperature of the water in the boiler and the latent heat of the H_2O contained in the gases. Hence combustion efficiency so far as it is under the control of the fireman $= \frac{\text{Available heat liberated}}{\text{Heat available in fuel}}$.

Analyzing the results of these heat-loss calculations it is found that in Test A, $1706 \times 100/2648 = 64.12$ per cent of the heat up the chimney is carried by the dry gases, and that the heat value of the CO amounts to $153 \times 100/2648 = 5.78$ per cent. The remainder, or 30.1 per cent, is carried off by the H_2O from coal and air.

TABLE 2 RESULTS OF APPLICATION OF FORMULÆ TO DATA OF TESTS B, C AND D

	Test B	Test C	Test D
a Heat carried to waste by dry gases, B.t.u.	2560	3480	4853
b Heat value of CO contained in gases, B.t.u.	251	0	57
c Heat in H_2O from combustion of available hydrogen, B.t.u.	610	497	549
d Heat loss due to humidity in air, B.t.u.	72		
e Heat carried to waste by water of hydration, B.t.u.	153	36	164
f Heat carried to waste by moisture in coal, B.t.u.	29	15	154
g Total heat in H_2O in gas, B.t.u.	864	548	867
k Total heat in flue gas per lb. of carbon burned, B.t.u.	3675	4028	5777
Heat of coal remaining in gases leaving boilers, per cent	20.43	23.17	32.14
Heat loss due to combustible in ash, B.t.u.	416	429	867
Heat loss due to combustible in ash, per cent of coal	2.31	2.47	4.82
Total Heat Loss:			
Heat absorbed by boiler, per cent	75.78	65.39	60.32
Heat loss up the chimney, per cent	20.43	23.17	32.14
Heat loss in range grates, per cent	2.31	2.47	4.82
Heat loss from radiation, etc., per cent	1.48	8.97	2.65
Total	100.00	100.00	100.00
Losses in Test Report:			
Moisture in coal, per cent	0.17		
Hydrogen in coal, per cent	4.49		
Heat to chimney, per cent	12.79		
Moisture in air, per cent	0.36		
Carbon monoxide, per cent	1.95		
Carbon in ash, per cent	2.13		
Total loss accounted for, per cent	21.89		
Heat absorbed by boiler, per cent	75.78		
Heat lost in radiation, etc., per cent	2.33		
Total	100.00		
Heat Balance in Test Report:		Per cent	Per cent
Heat absorbed by boiler (= evaporation from and at 212 deg. per lb. of combustible)		62.33	64.20
Loss due to moisture in coal (= per cent of moisture referred to combustible)		0.09	0.96
Loss due to moisture formed by burning of hydrogen (= per cent of hydrogen referred to combustible)		3.28	4.18
Loss due to heat carried away by dry chimney gases (= weight of gas per lb. of combustible)		19.75	26.60
Loss due to unconsumed hydrogen, heating of moisture and unaccounted for		9.55	3.74
Loss due to incomplete combustion of carbon			0.32
Total		100.00	100.00

TABLE 3 ANALYSIS OF HEAT ESCAPING UP THE CHIMNEY

	Test A	Test B	Test C	Test D
(1) Per cent of heat up the chimney contained in the dry gas	65.20	69.66	86.40	84.02
(2) Per cent of heat escaping up the chimney represented by CO	5.80	6.83	0.00	0.98
(3) Per cent of heat escaping up the chimney due to H_2O	29.00	23.51	13.60	15.00
(4) Per cent of heat controllable in item (1)	27.00	48.43	69.40	78.26
(5) Per cent of heat controllable in item (2)	100.00	100.00	100.00	100.00
(6) Per cent of heat controllable in item (3)	8.50	7.80	11.20	7.50
(7) Per cent of controllable heat residing in the dry gas	85.20	94.90	97.40	98.70
(8) Per cent of excess air	23.00	29.00	97.00	160.00
(9) Per cent of free oxygen in gas	4.16	4.83	10.57	13.10

Since the gases cannot be cooled below the temperature of the water in the boiler, it is evident that only the heat contained in the gases above that temperature is under control of the boiler operation.

Applying Formula [12] it is found that the theoretical maximum percentage of CO_2 obtainable from the coal used in Test A is

$$P_m = \frac{21}{1 + (2.38 \times 0.055)} = 18.57$$

The temperature of the water in the boiler corresponding to the average steam pressure carried during Test A was 384.6 deg. fahr. Applying Formula [4], the uncontrollable heat in the dry gases per pound of carbon burned is found to be

$$L_d = 0.24 + \frac{58.46}{18.57} \times 384.6 = 1246 \text{ B.t.u.}$$

or

$$\frac{(1706 - 1246) \times 100}{1706} = 27 \text{ per cent}$$

hence only 27 per cent of the heat in the dry gases in this test was controllable.

The loss due to CO is independent of the stack temperature, and since the percentage of CO in the gas can be reduced to zero, the heat loss due to its presence is 100 per cent controllable.

Since the heat loss due to the H_2O in the gases is independent of the CO_2, only that portion is controllable which is affected by the temperature of the flue gas above that of the water in the boiler.

The latent heat of evaporation is not controllable, hence the terms in the formula representing it must also be eliminated. Thus, applying the modified formula to the observed data we have for the controllable heat in H_2O:

$$\left[4.32 \times 0.055 + 0.0106 \times \left(\frac{117}{14.9} + 3.84 \times 0.055\right)\right] \times (583 - 385) + 0.48 \times (583 - 385) \times 0.143 = 67.53 \text{ B.t.u.}$$

Since the total heat carried to waste by the H_2O in the gas is 798 B.t.u., it is seen that only $\frac{67.53 \times 100}{798} = 8.5$ per cent of it is controllable.

Of the heat in the dry gas $(1706 - 1246 =)$ 460 B.t.u. were controllable, hence the total controllable heat escaping amounts to $460 + 67.5 = 527.5$ B.t.u., and of this $\frac{460 \times 100}{527.5} = 87.2$ per cent resides in the dry gases.

Table 3 gives the results of the foregoing calculations for the four tests under consideration. Item (1) shows what percentage of the heat wasted up the chimney is contained in the dry gas that can be controlled to a greater or lesser degree by improving operating conditions. Item (7) shows what percentage of the controllable heat resides in the dry gases. All of which emphasizes the importance of the CO_2 and temperature records, as controlling factors in boiler operations.

The fireman must drive his boilers in accordance with the demand for steam. He has no control over the condition of the heating surface of his boilers. And since the temperature of the escaping gases depends primarily on one or both of these conditions it is not fair to him to judge his proficiency by heat wasted up the chimney, and much less fair is it to judge him on the basis of pounds of water evaporated per pound of coal burned. In Test A, for example, there was 10 per cent more water evaporated than in Test B, while the difference in furnace efficiency based on heat available was only 2.4 per cent, as demonstrated above.

The proper basis upon which to judge the proficiency of a fireman is the factor $0.24 + \frac{58.46}{P}$ after the maximum percentage of CO_2 (P) with practically complete combustion has been established for the prevailing conditions at any given plant.

Within proper limits of CO_2 there exists no relation between the percentages of CO_2 and CO. Test B, for example, shows 0.7 per cent less CO_2 and 0.13 per cent more CO. Furthermore, it must be borne in mind that the loss due to the same percentage of CO diminishes directly as the percentage of CO_2 increases, as is shown by the factor $\frac{P_c}{P + P_c}$. It is a matter of easy calculation

(Concluded on page 199)

THE NAVAL AIRCRAFT FACTORY

In his strikingly interesting lecture on the engineering achievements of our Navy in the war, given at the Annual Meeting, Lieut.-Commander Cathcart limited himself to a recital of the work of a single bureau of the Navy Department—the Bureau of Steam Engineering.[1] "The work of this bureau," he said, "should be regarded as but a sample of what all the bureaus of the department have done. From the beginning of the war the entire Navy Department has been working in a clean-cut American way, at maximum efficiency under forced draft."

One of the most noteworthy of its accomplishments—that of another bureau—has been the construction and organization of the great naval aircraft factory at the League Island Navy Yard, Philadelphia, and the bringing it up to quantity production in 10

Commander F. G. Coburn, Manager, Naval Aircraft Factory

months from the time work on the first building was started. It was a pioneer undertaking, attended by innumerable difficulties, which, however, were but the measure of the possibilities that it was hoped might be realized. That they were actually realized is attested by the fact that from the first the factory has been ahead of its schedule.

On July 27, 1917, Secretary Daniels authorized the construction of a government-owned aircraft factory. The site selected was a 40-acre tract of pasture land at League Island, entirely undeveloped. The original manufacturing unit was a permanent steel structure having a ground area of 160,000 sq. ft., built and equipped in three months and put in operation before the final touches had been given to the structure.

Early in January 1918 the Navy's aircraft program was expanded far beyond the manufacturing facilities of this original building and plans were developed for the enlargement of the plant to four times its original size. The augmented program required new aircraft faster than they could be provided by building an entirely balanced factory. The authorization therefore contemplated that the new extension should be an assembly plant and in proportion to its growth, privately-owned manufacturing facilities be taken off their regular commercial work and placed under contract to furnish the hulls, wings and other parts needed. Thus branches of this establishment appeared in many places throughout the East which turned their activities to a common end under the direction of the Naval Aircraft Factory.

When the armistice was signed the enlarged plant comprised, besides the original building, 400 ft. square, the new Plant No. 2, over 1000 ft. long, with a high assembly shop 200 ft. wide for the largest types of aircraft, and a one-story ell 350 ft. wide; a storehouse 200 by 175 ft.; administration building 180 by 125 ft.; lumber storage and dry kilns; boiler house; hangars, etc., comprising 25 acres of floor space and a capacity of four seaplanes per day.

At this time 3740 men and women were employed at the factory, besides 8000 by outside contractors.

The chronology of this extensive development is as follows:

July 27, 1917, Secretary Daniels authorized construction.
August 10, construction work began.
October 16, first machinery started.
November 2, first keel laid.
November 28, first plant completed.
January 25, 1918, expansion of plant ordered to four times original size.
March 27, first service machine completed.
June 1, full designed production of first plant attained.
November 4, 1918, production of two completed hulls a day and plant capacity sufficient to produce four machines a day.

In view of the special character of the undertaking, in what in this country was a little-understood field, this record of progress is in many ways unprecedented. As a patriotic accomplishment on a vast scale, it is one in which the Navy Department may well take pride; and as an example of efficient organization and able able administration it must be classed as a real achievement.

Commander F. G. Coburn, Manager

The manager selected for the undertaking, and who has so successfully carried it through to completion, is Commander F. G. Coburn, Mem.Am.Soc.M.E., who was previously stationed at the Boston Navy Yard. Members of the Society will remember the comprehensive paper presented by Commander Coburn at the Annual Meeting three years ago, on the heat treatment of wrought iron, a subject at that time but little understood. This gave the results of an elaborate investigation for the purpose of improving the strength and reliability of heavy anchor chain forged at the Boston Navy Yard for the U. S. battleships.

Commander Coburn is a graduate of Annapolis and of the Massachusetts Institute of Technology, where he qualified as a naval architect and marine engineer, with the degree of Master of Science. He served one year as a line officer in the Asiatic service, and had some 10 years' industrial experience in several of the navy yards of the country, where he became interested in scientific management and gave considerable time, also, to investigations of the methods of civil industrial plants. All of this experience, as well as initiative, visions and the ability to undertake new and great things had ample opportunity to come into play in the new project upon which he embarked.

Organization of Staff and Working Force

It is coming to be generally recognized that in any manufacturing enterprise the personnel is the most essential element. Buildings can be erected and machinery purchased, but to do effective work an organization must be built up with infinite pains and its methods of work in the different departments carefully coördinated.

What shall be said, then, of a project such as this, where the organization had to be formed at the very start, with no time for experimenting, and in a field where there were practically no men experienced in the art upon whom to draw; for what few there were in this country who had had any experience in aircraft production were already in war work in other aircraft factories.

The executive staff was first got together, selected by Manager

[1] See Mechanical Engineering, January 1919, p. 18.

Fig. 1 Panoramic View of Naval Aircraft Factory; Original Plant at Extreme Left, New Assembly Shop at Right, Administration Building and Storehouse in the Center

Coburn from civil life, as the Navy could spare but one more officer, Lieut.-Com. F. J. Daly, Pay Corps, who became Supply Officer.

Upon the employment department fell the problem of supplying man power for the factory. Civil Service rules and the regulations of the Navy had to be taken into consideration at every step. Testimony to the generally satisfactory caliber of employees secured under Civil Service, however, is found in the fact that it was necessary to hire a total of only 6035 persons to provide for the nearly 4000 at work at the cessation of hostilities and only 139 had been discharged for cause.

The story of the building up of the force is full of interest. The hulls of the seaplanes were the most difficult parts to construct and boat builders were essential, but where were they to be found with the Emergency Fleet Corporation in operation, and supposedly using every available shipbuilder? A representative of the Naval Aircraft Factory went to the Jersey coast, however, and prevailed upon nearly 80 boat builders to leave their own personal work and come to the factory to "do their bit" in helping to put the U-boat out of commission. Among them were old boat builders who owned shops near their homes and who consented to close their doors for the time being and join forces in the new undertaking. One of these was the newly-elected mayor of the small city in which he lived. Trained by long experience to do all of a job, these men readily fitted into the aircraft work after a brief course of instruction at the factory school.

Specialists in aircraft production were picked up here and there, often by chance, for other parts of the work. A Belgian soldier and former aviator who had escaped from a German prison camp, applied in person, specifying in his enthusiasm that he should work not less than 12 hours a day. A French infantryman who had previously studied motor construction in this country and was wounded at the front, returned to America, learned of the League Island factory through the War Community League at one of the Philadelphia railroad stations, and secured an important position there. And so, little by little, but nevertheless with rapidity, the force was built up and placed effectively at work.

Employment of Women

From its inception, the Naval Aircraft Factory employed women for clerical work and in December 1917 they were first used in the Inspection Department, to inspect screws, bolts, turnbuckles and small metal parts. This work required accuracy, good judgment and common sense, but very little previous experience or training. In order that their services might be extended to other departments where previous experience and special skill were required, a training school for women was started in May 1918. The women are placed in this school when employed, where they are given training in factory processes. They are here tried at various kinds of work and are then trained to do the thing for which it is observed they are best fitted. This is determined by a daily record of the work of each woman for one month, whose grade of work and adaptability for that work are discussed with her immediate superior; and everything possible done to make her contented and efficient.

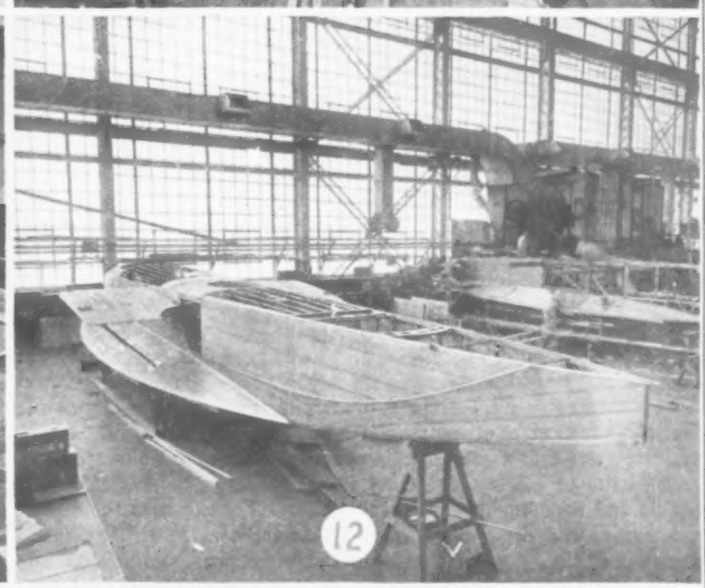
At the close of the war activities 900 women were employed in the factory, most of them having come through the training school, equipped to serve capably in many of the departments of the works. In the mill they are employed on the spruce layout, on band saws and molding machines and as helpers. In the hull cover department they help with parts of the hull cover and also construct alone small parts, such as gun mounts and access doors. They are employed exclusively in jigging, reinforcing and sandpapering the webs preparatory to their use in the panel, or wing, assembly. In the panel shop they are used to a great extent in the construction of elevators, rudders, stabilizers and

Fig. 2 Plant No. 1, shown at the Left in Fig. 1

NAVAL AIRCRAFT FACTORY

Fig. 3 Assembly and Hull Shop, Plant No. 1
Fig. 4 Seaplane on Cradle
Fig. 5 Lumber Mill
Fig. 6 Training School for Girls
Fig. 7 Metal Shop
Fig. 8 Panel Assembly Shop



NAVAL AIRCRAFT FACTORY

Fig. 9 Seaplane Afloat, Fully Loaded
Fig. 10 Final Assembly, Plant No. 2
Fig. 11 Propeller Shop
Fig. 12 Hull Assembly; also showing Humidifying Apparatus
Fig. 13 Panel Shop
Fig. 14 Dope Room for Panels

panels of all types. They then cover these parts with linen or cotton fabrics preparatory to their going to the dope room.

In the machine shop, women operate the drill presses, wrap, solder and splice wires and cables; and file and weld metal parts. In the pontoon department they help construct the wing floats; and in the boat shop they help in planking the hulls and perform small operations in hull and final assembly. Women are used to a great extent in the storerooms and tool cribs. They are used in drafting and operating the blueprint and photostat machines and also some testing machines in the engineering department.

It is interesting to note that the factory has three forewomen who have "made good" and accomplished much in expediting production.

The women work the same hours as the men, i.e., 49 hours a week, making a 9-hour day during the week and a half-day of 4 hours on Saturday. They are paid on an 8-hour basis and make time and a half for overtime and Sunday work. The factory is operated on the plan of equal pay for equal work and when a woman is able to equal the output of the men she receives the same pay. In most cases, however, the women have not yet had sufficient experience, or are not able physically to reach such an output and receive correspondingly less wages.

The working conditions are made as favorable as possible for the health and comfort of the women and particular attention was paid to this so that in spite of long hours and unusual exertion they might be able to hold their own during the period of the war with no bad post-bellum results. Necessarily the work is tedious and hard for many. They must rise early, commute long distances, walk a mile to the factory from the Navy Yard gate, and work nine hours. Nevertheless, they have done it faithfully and patriotically, making their contribution in this way to the great cause of freedom.

CONTRACT WORK

The great number of seaplanes to be constructed, and the early date set for their completion, made the building of them all in a single plant an impossibility. Not only was the time too short for the erection of the necessary buildings, but the matter of training the many workmen required would occasion a delay beyond the time allowed.

The full capacity of the Naval Aircraft Factory was therefore determined and every unit entering into the construction of hulls and wings that could be built in the plant was retained as its quota of the production program. It was decided to contract with such factories as were fitted to do the work for the balance of the program.

For this purpose, a new department was organized, termed the Contract Manufacturing Department, having as its function the distribution of work to sub-contractors. A conference between departments resulted in a schedule being compiled of all the seaplane elements which were in excess of the Aircraft capacity, such parts to be procured outside.

A careful survey was made of all plants capable of handling the work with the idea of giving each one the quantity of work it could complete by the time the entire program must be finished. Only such plants were considered as were equipped with the necessary machinery and positive assurance was required that the requisite number of skilled workmen was immediately available. By placing contracts in this way an economy in time and cost was made possible, as each plant became a specialist in the construction of its particular unit.

A number of well-equipped and reputable yacht-building concerns were awarded contracts for the construction of the boat hulls. Smaller boat shops, furniture and cabinet factories were awarded contracts for the building of panels (wings) and tail surfaces. The metal fittings, of which there are thousands, were awarded to shops equipped with modern automatic machinery and the necessary heat-treating apparatus. As previously stated, about 8000 people were engaged in the outside manufacture of these parts, which were shipped to the Aircraft Factory and there assembled.

THE ENGINEERING AND OTHER DEPARTMENTS

A vital part in the successful production of the factory has been the large and well-organized Engineering Department under the direction of the Chief Engineer, Major G. R. Wadsworth of the Signal Corps. This is made up of the following divisions:

Experimental, comprising construction of new parts, material and types; assembly and erection; testing plane and engine performance and accessories.

Design, embodying inventions; experimental design; cost estimates; records and issues; production drafting, blueprinting, etc.

Specifications and Intelligence, covering technical data from periodicals and other sources; specifications of materials and processes; instruments, accessories, performance, etc.

Inspection, comprising inspection of materials at source; in stockroom; in process of manufacture; and inspection during erection, final acceptance test, and packing.

Testing, chemical and physical, metallurgical, strength of materials.

Trials of completed planes; besides several other divisions, such as *Engineering Service*, *Wood Technology* and *Photographic Work*.

The responsibilities resting on this department are very great because of the combination of strength and lightness required in aircraft, and the almost infinite care which must be exercised to secure both workability and safety. Skill in design and alertness in inspection are both vital. A staff of 125 inspectors is required for the work of inspection.

A department known as the Manufacturing Office receives the requirements of the Navy Department and accumulates all necessary data for the requisition of materials, issuance of orders to all factory departments and the scheduling of work and equipment. The clerical work of production is concentrated here to leave the executives of the manufacturing departments free for the closer supervision of actual production.

The Contract Manufacturing Department has the responsibility of keeping the large assembly plant going to capacity by supplying the component parts of the finished product for final assembly. The Supply Department uses every means of rapid transportation for the earliest possible delivery. In each of the subsidiary shops doing contract work is stationed a representative from the main factory who acts as branch manager and is responsible for results.

STANDARDIZED SEAPLANE

The standard seaplane manufactured at the Naval Aircraft Factory is of the flying-boat type, equipped with two Liberty motors and having a speed of 100 miles an hour and a cruising radius of 10 hours. It carries five men, four machine guns, four bombs, 500 gal. of gasoline, wireless and other equipment and weighs, with its crew, about 14,000 lb. The construction of the panels or wings, built up of a skeleton of spruce webs and piano-wire braces, is familiar to all. The webs are but 1/4 in. thick, cut out in the center and ends, and braced by small battens, less than 1/16 in. thick, which are stapled to them. Similar construction, but heavier, is followed in the boat. Tubular steel struts and tension wires reinforce the entire structure. Multiple-ply veneer less than 3/16 in. thick is used for planking. The prototype of this flying boat was the *America*, built for Mr. Rodman Wanamaker by the Curtiss Aeroplane Co. before the war for a transatlantic flight; the war broke out before the flight was attempted.

It is not the purpose of this article, however, to describe the details of construction of naval aircraft, nor to consider the intricate processes of manufacture; but rather to place on record a noteworthy accomplishment in industrial development for the prosecution of the war. The accompanying illustrations tell their story of the extent of the plant and of the volume and complexity of the work in process. L. G. F.

The first of a series of instructive bulletins on Employment Management has recently been issued by the United States Shipping Board, Emergency Fleet Corporation.

THE PATENT SITUATION IN THE UNITED STATES

At the meeting of the New York Section held January 14, 1919, a paper was presented by Edwin J. Prindle, Mem.Am.Soc.M.E., on the Patent Situation in the United States which reviewed the recent movement to increase the efficiency of the Patent Office. Mr. Prindle is a member of the Patent Committee of the National Research Council appointed at the request of the Commissioner of Patents with the approval of the Secretary of the Interior, to investigate the Patent Office and the patent system, with a view to making recommendations for improvement in this department of the Government and in the patent system as a whole.

Since his paper was presented, the report rendered by his committee has been approved by the Commissioner of Patents, by the National Research Council and by the Engineering Council and has been released for publication. The substance of the report has been incorporated in what follows, with a preliminary explanation taken from the introductory portions of Mr. Prindle's paper. In connection with the report, it should be stated that three bills have been drafted to be presented to Congress during the early part of its next session, with the expectation of putting into effect the provisions of the report.

Introduction By Edwin J. Prindle

Various events make the patent situation in the United States of especial interest at this time. The exceedingly important part played by inventions in the war has shown the desirability of increasing the incentive to produce inventions. The intense competition which will come from the strivings of the debt-laden countries of Europe to rehabilitate themselves will result in every possible effort to stimulate their own inventors, and this will make it necessary that we see to it that our inventors have the fullest incentive consistent with a sound policy. A movement is already on foot, seeking to improve the efficiency of our Patent Office and patent system and which, directly and indirectly, will improve the inventor's position.

The present movement seeking to increase the efficiency of the Patent Office and of the patent system was started by the Society of Patent Office Examiners, at whose request the Commissioner of Patents, with the approval of the Secretary of the Interior, asked the National Research Council to appoint a committee for the purpose of investigating the Patent Office and patent system and making recommendations to those ends.

The reason for asking the National Research Council to undertake this work was that the Council is a body of such high scientific standing and so free from any suspicion of a bias or selfish interest in the subject that its recommendations would be likely to have the maximum weight with Congress for any legislation which should become necessary.

The National Research Council complied with the request and appointed a committee consisting of Dr. William F. Durand, Chairman; Drs. Leo H. Baekeland and M. I. Pupin, scientists and inventors; Drs. R. A. Millikan and S. W. Stratton, scientists; Dr. Reid Hunt, physician; and Messrs. Frederick P. Fish, Thomas Ewing and myself, patent lawyers. I was appointed as the representative of this Society. On the departure of Dr. Durand for Europe, Dr. Baekeland was appointed Acting Chairman of the committee.

This Patent Committee has made a report to the National Research Council, accompanied by carefully drafted bills ready to be introduced into Congress if the report is approved.

The United Engineering Society also appointed a Patent Committee for the same general purposes as that of the National Research Council and instructed it to coöperate with the Committee of the National Research Council and with committees of other technical societies organized for a kindred purpose.

Dr. David S. Jacobus and I were designated to represent The American Society of Mechanical Engineers on the Patent Committee of the United Engineering Society. The American Society of Civil Engineers is represented by Messrs. C. A. P. Turner and Leonard Metcalf; the American Society of Mining Engineers by Messrs. J. Parke Channing and Horace P. Winchell; and the American Society of Electrical Engineers by Messrs. Charles A. Terry and Frank N. Waterman. Mr. Terry is chairman of the committee.

REPORT OF PATENT COMMITTEE TO THE NATIONAL RESEARCH COUNCIL

The Committee has concluded to propose a program consisting of but four features, because it believes those features are of such fundamental importance that their enactment into law would strengthen the entire system and directly and indirectly establish it upon a new and much more advantageous footing before Congress and the public; and because with a simple program, presenting comparatively little opportunity for difference of opinion as to the desirability of the changes proposed, there would be an unanimity of opinion in support of it which could not be obtained if the program were more extended.

A Single Court of Patent Appeals

The first proposal which your Committee recommends is the establishment of a single Court of Patent Appeals that will have jurisdiction of appeals in patent cases from all the United States District Courts throughout the country, in place of the nine independent Circuit Courts of Appeals in which appellate jurisdiction is now vested.

Until 1891 the Supreme Court of the United States was the appellate court in patent cases for all the lower courts. At that time the right of appeal to the Supreme Court in patent cases was taken away, and that Court now hears patent cases only upon writs of certiorari, which are never granted unless certain very unusual conditions exist.

The existence of nine appellate courts of concurrent jurisdiction in patent cases works serious hardships. While, theoretically, the law is the same in all of these courts, there has been an irresistible tendency to drift apart in the application of the law. It has even happened in a substantial number of cases that two of the appellate courts have taken a different view of one and the same patent. It is, of course, very important that the questions which always exist as to the validity and scope of a patent should be settled once and for all at the earliest possible date in the life of the patent, for, as a practical matter, 17 years (the term of a patent) is a comparatively short time in which to reduce the invention to a thoroughly commercial form, to prepare for its manufacture, and to introduce it upon the market, and it is usually necessary to determine the validity and scope of the patent in order to determine the amount of money which it is safe to invest in exploiting the invention. As things are now, whichever party succeeds in the first suit that is tried on the patent, the other party is very likely to feel that in a second trial before another court he might have better luck. He, therefore, is inclined to insist upon a second litigation. Meantime, he advertises that the questions involved were not settled in the first case. This means uncertainty on the part of the owners of the patent as to their rights and uncertainty on the part of the public as to its rights to use the invention or to determine what it must avoid in working in the same field—a really intolerable situation.

Moreover, we shall never have a uniform and definite patent law, consistently applied, until we have a single Court of Patent Appeals independent of local sentiment, realizing a responsibility to fix the principles of the law and enforcing an harmonious application of these principles on the lower courts. It would be of the utmost value to those in the United States who are engaged in industry if the present confused condition could be corrected and a single tribunal created to devote itself to crystallizing the fundamentals of the patent law and to educating the courts throughout the land to uniformity in applying these principles in special cases.

The increased expense due to such a court would be small. The aggregate amount of work to be done by the Judges of the United States Courts as a whole would not be changed to any substantial extent, because all appeals must now be heard by the present courts and Judges and, if there were a single Court of Patent Appeals, the Courts of Appeal in the nine circuits would be relieved of just as many appeals as were heard by it. The Judges in some of the circuits are much overworked, but this is not true of many of the circuits. The Chief Justice of the United States Supreme Court, in selecting these Judges, could, if he chose, take into account the work of the different circuits and whether one circuit or another could best spare a Judge.

As the law now stands, Judges from one circuit may be called upon, and not infrequently are called upon, to go into other circuits which are short-handed. In this way, any undue pressure upon the Judges in any particular circuit, by reason of the loss of any single Judge who went to the Court of Patent Appeals for six years, could be relieved.

A further advantage is that a single Court of Patent Appeals would see clearly where there were defects in the statute and in the conditions and practice in the Patent Office, and could speak with authority on all matters which affect the theory and practical working of the patent system.

The Patent Office a Separate Institution, and Independent of the Department of the Interior

The second proposal which your Committee recommends is that the Patent Office be made a separate institution, independent of the Interior or any other department.

The Patent Office was originally in the State Department, but, on the formation of the Interior Department in 1849, it was made a bureau of that Department and has been so ever since.

The only matters connected with the Patent Office with which the Secretary of the Interior has anything to do are the following: The Secretary of the Interior must submit to Congress all estimates for appropriations. All appointments, excepting those of the Commissioner, two Assistant-Commissioners, and five Examiners-in-Chief, are made by the Secretary but only on the recommendation of the Commissioner. The eight places named are Presidential appointments, but the Secretary makes recommendations to the President. All matters of disbarment or reinstatement after disbarment of attorneys are passed upon finally by the Secretary. All matters of discipline are under the Secretary's jurisdiction. The Secretary of the Interior must approve all changes in the Rules of Practice of the Patent Office, but he cannot compel the commissioner to make any change whatsoever.

No appeal lies to the Secretary from any decisions of the Commissioner, either in matters of merit or practice. All such matters, as far as they are reviewable, rest with the courts of the District of Columbia.

The Secretary of the Interior no longer signs the patents, and has no jurisdiction to grant or refuse them.

Thus it will be seen that the Secretary of the Interior is not required to know anything about patents or patent law. He is not selected because of any qualifications for the granting of patents or supervision over the Patent Office. The Secretary of the Interior has less influence over the Patent Office than over any other bureau of the Interior Department, because there are appeals to him from all the other bureaus. Nor is the Patent Office related to any other bureau of the Interior Department.

The Secretary of the Interior has recently moved out of the Patent Office building, thus severing physical contact with the Patent Office, which is but a type of the lack of mental contact between the office of the Secretary of the Interior and the Patent Office.

The experience of many Commissioners over a period of several generations has shown that, no matter how pleasant the personal relations may be, the Commissioner of Patents cannot expect any real benefit to the Patent Office to flow from its connections with the Interior Department. There is nothing in common between the interests of the Interior Department and those of the Patent Office, and, consequently, nothing to produce any advantage from the amalgamation of the Patent Office into the Interior Department.

Your Committee believes that to make the Patent Office an independent bureau would greatly increase the respect of the public and Congress and the courts for it, and would make it easier to procure enlarged appropriations and better salaries than under present conditions.

As to appropriations, under present conditions the demands of the Patent Office for equipment, personnel and salaries are necessarily subjected to comparison both by the Secretary of the Interior and by Congress with those of several other unrelated bureaus, each pressing its own demands and criticising any apparent preference. In the opinion of your Committee, this operates as a severe handicap. In estimating the needs of the Patent Office, there should be no discussion of the demands, for example, of the Pension Office or the General Land Office. As an independent institution, the needs of the Patent Office would be judged on their necessity and the appropriations be determined by considerations of general policy.

As to personnel: The enhanced dignity and independence of the Patent Office would render all positions of importance in it more attractive, and particularly would make it easier to secure and retain in office men of the necessary qualifications to fill the difficult office of Commissioner.

Increase in Force and Salaries of the Patent Office

The third proposal which your Committee recommends is a substantial increase in the force and salaries of the Patent Office. The patents granted by the United States Patent Office are of less average probable validity than formerly, because the number of applications for patents and the field of search are constantly increasing, while the examining force for many years has been insufficiently large and has not been increased proportionately. The inducements are so unattractive that 25 per cent of the examining force has resigned within the past three years. Your Committee finds that the Patent Office is suffering both from lack of examiners and from inadequate compensation.

The salaries of the Patent Office examiners have been increased only 10 per cent since they were fixed in 1848, when they were approximately the same as those of members of Congress. At the time the salaries of the Examiners-in-Chief were fixed, they were the same as those of Federal District Judges. During the past 70 years, the compensation for technical service in almost all other directions has been increased very largely. Congress, in creating new positions, is willing to pay technical men salaries more nearly approximating the usual compensation of such men in private service, but, having started a position at a given salary, is very loath to increase the salary. A Principal Examiner, to pass the entrance examination for the Patent Office, must himself have an education equivalent to that of a college graduate, and yet his salary is so low ($2700 a year) that it is practically impossible for him to give his own sons a college education.

Your Committee believes that salaries should be paid to the examiners proportionate to those paid for equally high technical work in other departments created recently; such, for example, as are paid in the Army and Navy and in the office of the Attorney General. The examiners are passing upon questions often involving millions of dollars, and they cannot be at their best in this vitally important work unless their salaries are large enough for them to live comfortably and without strain. The chances of making mistakes in the granting of patents are great enough even under the most favorable circumstances, and they should not be increased by compelling the examiners to work for inadequate salaries. The inducements should be such as to present compensation and a career which would attract and hold men of the highest ability. The payment of adequate salaries and the creation of provisions tending to hold out attractive prospects to the examiners would also tend to raise the dignity of the Patent Office and to increase its standing in the estimation of the public and of Congress and the courts, and so would tend to enhance the value to the public of the patent system.

The work of the Patent Office has grown so much more rapidly than has the examining force that the examination to determine whether or not the invention claimed in an application for patent is novel is imperatively restricted to the field of search where it is most likely that the invention will be found. Many patents are granted which would not be granted if the examiner had time to make a thorough search. One of the Assistant-Commissioners of Patents is compelled to devote a large amount of his time to speeding the work of the examiners in order to prevent further falling behind in the number of unexamined cases. Money is often invested on the strength of patents, only to find later that the patent is upset in the courts, because the Patent Office search did not go far enough to discover that the invention had already been disclosed in some earlier patent or publication. The granting of a patent with invalid claims or claims which are too broad or which are nebulous is a menace to the art to which it relates, and until such a patent has been adjudicated and its effect judicially determined, it tends to prevent manufacturing and commerce in that art. Such a patent may, in this way, cost the public many millions of dollars beside the cost of establishing its invalidity or its true breadth or meaning by litigation, and the prevention of the granting of such patents by any reasonable increase in the examining force of the Patent Office would, in many cases, be a very large saving. The inducement to inventors and investors in patents is consequently lessened, the standing of patents before the courts and the public is impaired, and the production of inventions discouraged.

Your Committee accordingly recommends a substantial increase in the salaries of the Patent Office officials, and in the number and salaries of the examiners, as provided in the draft of a bill for that purpose.

While your Committee believes the Patent Office so fully justifies its existence that it would be an exceedingly profitable investment, even though all expenses were paid from the public income, the Patent Office has always been self-supporting and the increase in salaries and examining force which the Committee recommends can easily be entirely taken care of by the Patent Office income, if necessary.

Compensation for Infringement of Patents

While an injunction can ordinarily be obtained against an infringer in a case where a patent is adjudged valid, except where it would interfere with Government work, a money recovery has not heretofore been generally possible except under most favorable circumstances. In a case where it cannot be said that the entire salability of the article depends upon the invention, it has been necessary to show just how much of the price of the article is attributable to the invention, and as it is ordinarily impossible to make such a separation, and as most patent cases are ones in which it cannot be said that the whole salability of the article depended upon the invention, it has resulted that recovery of money is seldom obtained in a patent suit.

Recently there have been two or three decisions in which the courts have taken a more liberal attitude, holding in effect that where an invention has been used by an infringer a reasonable royalty may be awarded to the patentee based on a mere estimation or on opinion evidence, even though no exact computation can be made. This is analogous to the attitude of the courts in personal injury cases and is entirely just and reasonable. While, as stated, there have been two or three decisions to this effect, it may take a generation to induce United States courts generally to adopt this position, if at all, and the Committee therefore proposes that the law be amended to provide, that as damages to the complainant, the court, on due proceedings had, may adjudge and decree to the owner payment of a reasonable royalty or other form of general damages. Such an amendment has been provided in the bill amending Section 4921, the Revised Statutes of the United States, and reading as follows:

"If proof is not offered or, in the absence of adequate proof of the amount that should be awarded as damages or profits, the court, on due proceedings had, may adjudge and decree to the owner payment of a reasonable royalty or other form of general damages."

This proposed amendment would enable the patentee in all suits where the patent has been found valid and infringed to recover at least a reasonable royalty, and would provide a money recovery in the great majority of patent suits where no recovery would otherwise be possible. The Committee believes that the comparative certainty of financial return would answer one of the most common and strongest reproaches against the patent system, namely,—that a patent does not ordinarily pay the inventor any money, and it believes that the incentive to invent would accordingly be greatly increased.

There are some cases in which it seems to many who are familiar with such matters as though the courts were inclined to go to the other extreme and award damages out of all proportion. Where a complainant has shown that profits have been made by the use of an article patented as an entirety, the infringer is liable for all the profits unless he can show—and the burden of proof is on him to show—that a portion of them is a result of some other invention used by him. If the infringer cannot show what proportion of the profits is due to such other invention, then all his profits must go to the complainant. Any rule by which the entire profits are given to a patentee in the absence of proof that they are all due to the invention of the patent sued upon, is unfortunate and sometimes very unjust. The proposed amendment to the statute would permit a court under these circumstances to do substantial justice even though it could not be mathematically exact. In other words, the amendment to the statute would enable a court to avoid awarding either too much or too little.

Conclusion

Your Committee, believing that the American Patent System is vitally useful in our system of Government, therefore recommends that the reforms herein discussed be enacted into law.

Your Committee also recommends that this report be approved by the National Research Council and that the Committee be continued for the purpose of arousing and coördinating interest in and support for the necessary legislation of various national societies, manufacturing interests, bar associations and other elements of the public.

Respectfully submitted.

L. H. Baekeland, *Acting Chairman*
William F. Durand, *Chairman* (absent in France)
M. I. Pupin
R. A. Millikan
S. W. Stratton (see reservation below)
Reid Hunt
Frederick P. Fish (see reservation below)
Thomas Ewing
Edwin J. Prindle

Approved by James T. Newton, *Commissioner of Patents*; by the National Research Council; and the Engineering Council. (See reservation in the Addendum, page 199.)

The reservation indicated above by Dr. Stratton is in respect to the establishment of the Patent Office as a separate Government institution. He is not convinced that this would be the best thing to do, since in general it is best for all Government establishments to be represented in the Cabinet.

The reservation by Mr. Fish calls for the omission of the words "if proof is not offered, or" in that portion of proposed Amendment to Section 4921 of the U. S. Statutes which deals with damages and profits, so that the sentence will read as follows: "In the absence of adequate proof of the amount that should be awarded as damages or profits, the Court, on due proceedings had, may adjudge and decree to the owner payment of a reasonable royalty or other form of general damages." He believes that no statute should directly or indirectly contemplate a condition in litigation in which "proof is not offered" and that the courts in applying the clause would be embarrased if the phrase "if proof is not offered" were in the statute.

(Concluded on page 199)

A NEW THEORY OF THE STEAM TURBINE[1]

By HAROLD MEDWAY MARTIN

(From articles published in *Engineering*)

IN THE investigation of the performance of steam turbines some notable discrepancies between theory and apparent practice were discovered, one of these being that under certain conditions the weight of steam discharged from a nozzle was actually greater than what was physically possible according to the then accepted theory. At first it was attributed to the moisture in the steam, but this explanation was discarded when it was found that to bring this theory into accord with experiment would involves the presence of anywhere between 10 and 20 per cent of moisture in the steam. Later on this anomaly was attributed to a fundamental error in the then accepted theory of the efflux of steam; namely, that the expansion of wet steam did not proceed under conditions of thermal equilibrium as was previously assumed.

The present theory is based on an assumption claimed to be proved by actual experience with steam turbines; namely, that not only is steam not in thermal equilibrium in the "saturated field" of the Mollier diagram, but it is never in thermal equilibrium until the condenser is attained. The relation between volume and pressure during the expansion of wet steam is accordingly never the same as if a state of thermal equilibrium were established.

In opening a turbine it is easy to see the difference in the appearance of the blading which has been exposed only to superheated steam and that which, on the ordinary theory, has been subjected to the action of wet steam. In the region where the steam was supersaturated a film of moisture is deposited on the blading and it is this very phenomenon that for a long time interfered with the detection of undercooling in steam turbines and steam engines. In any attempt to take the temperature of the steam by means of a thermometer a film of moisture was immediately deposited on the bulb or on the exterior of the thermometer pocket if the steam were supersaturated, and the thermometer recorded the temperature of this film and not that the surrounding vapor. Hence, for many years it has been noted that the temperature of the steam as indicated by a thermometer placed in a turbine exhaust pipe was sensibly below that corresponding to its pressure. These low readings are all the more remarkable in that experiment has shown that when a thermoscope is immersed in a current of permanent gas it tends to give too high a reading, owing to adiabatic compression of the fluid against the obstacle.

The writer mentions a possible objection against the idea that there is any large degree of undercooling in the turbine exhaust, viz., the fact that in experiments with a nozzle discharging into open air Dr. Stodola showed that once condensation commenced it proceeded with extreme rapidity. However, he calls attention to the fact that the occurrence of condensation or even its completion does not necessarily imply the simultaneous establishment of thermal equilibrium. In fact, there is evidence in favor of the view that there is a sensible lag between the two.

In the experiments of Stodola the droplets observed by him in his jets of undercooled steam were formed in a period of time of the order of one ten-thousandth of a second, while the time occupied by steam in flowing through the low-pressure end of a turbine is some hundred times as great. Were it not for the lag between condensation and thermal equilibrium, it is difficult to see how these droplets could be built up with such rapidity. Each molecule as it condenses liberates energy sufficient to raise its own temperature by some 500 or 600 deg. cent. and were this energy immediately and wholly transformed into heat, it is difficult to see how the temperature of the surface could be kept low enough to permit of the building up by further condensation of the droplets observed by Dr. Stodola.

The writer also brings forward the following interesting reasoning to prove that the instantaneous conversion into heat of the energy liberated on condensation is unlikely. He claims that the forces responsible for the attraction between the molecules of the same substances to which the phenomenon of liquefaction is due, are essentially of the same nature as the forces holding together a chemical compound, i.e., electrical. There are thus good grounds for believing that the energy liberated on the condensation of a vapor is at the outset represented by electrical disturbances and is only somewhat gradually converted into the form of heat. In support of this view he cites the paper of Wilson in the *Philosophical Transactions* for 1897, where the latter states that if the expansion of dust-free vapor was just sufficient to produce condensation the number of droplets formed was of the order of 10^5 per cu. cm., but that this number increased very rapidly if the range of expansion was increased. This affords direct proof that the additional condensation took on new nuclei and the temperature of the vapor must accordingly have been far below the equilibrium value during the whole range of expansion. The time taken for the expansion in Wilson's experiments was estimated at something over 1/50 of a second and was thus of the same order as the total time taken for steam to pass completely through a modern steam turbine, the inference being that the steam as finally discharged from such a turbine is used in a greatly undercooled and supersaturated condition.

The writer in the present paper attempts to show that if his interpretation of Wilson's results be accepted i. e., that the expansion continues with the vapor temperature far below that which would be indicated by any thermometer immersed in it), both superheat and vacuum corrections can be rationalized, while a contrary view involves wide discrepancies between theory and practice.

It is a well-known fact that in steam-turbine practice the gain made by the use of superheated instead of saturated steam is substantially more than is thermodynamically due. This was shown quite conclusively by Baumann in a paper read before the Institution of Electrical Engineers (British) in 1912. Last year an extended set of correction tables drawn up by C. H. Naylor was issued under the auspices of the British Electrical and Allied Manufacturers' Association. From these figures, combined with the heat-drop tables issued by the same association, the present author secured the following figures of relative consumptions under certain standard conditions:

TABLE 1

Superheat, deg. fahr.	0	50	100	150	200	250	300
Relative consumption	1.160	1.101	1.046	1.000	0.9592	0.9235	0.8909

From these figures and other data it would seem that the saving due to a superheat of 150 deg. fahr. is reckoned at 16 per cent instead of at 15 per cent as in Baumann's paper in 1912. This may be due to the improvement effected during recent years in average turbine efficiency, since, as the writer claims, with any given type of turbine the relative gain from using superheat should increase somewhat with the efficiency of the turbine. This is the reverse of the opinion generally held.

From this the writer proceeds to the consideration of the discrepancies between the gains and losses. To do this he takes for purposes of comparison the condition of the steam, not as supplied to the stop valve but after passing through the governor valve. In addition, the discrepancies are made larger by the fact that the ratio of blade speed to steam speed is, on the average, less the greater the amount of available heat. Furthermore, the

[1] Abstract of an important paper which appeared serially in the latter part of 1918 in *Engineering* (London). While the first installments were reported in THE JOURNAL for September, October and November 1918, it has nevertheless been deemed desirable to present in one issue a conjoint abstract of the entire investigation. Because of the lack of space one section of considerable interest abstracted in the September issue has been omitted here. This refers to the modified Callendar steam table and directions for using it.

heat which becomes available in a steam turbine differs from the adiabatic heat drop and is, in general, considerably larger. The ratio of the two, known as the reheat factor, forms the subject of an important discussion by the writer, who claims that it is substantially greater for superheated than for saturated steam when the latter is assumed to be in thermal equilibrium throughout the whole of its expansion.

Suppose a turbine to consist of an infinite number of stages. At each stage a certain portion of the total energy of the steam is converted into kinetic energy, of which a part is expended in doing useful work on the shaft, and the remainder, which is wasted in friction, is restored to the expanding steam in the form of heat; the consequence is that at each stage the pressure corresponding to a given volume of the steam is somewhat greater than it would be did the turbine work friction-free. Whether steam be used to actuate a turbine or a reciprocating engine the amount of work done down to any stage of the expansion can be represented by an ideal indicator diagram such as is shown in Fig. 1. In this the expansion line BD is that corresponding to frictionless working or to unit efficiency, while BE represents the expansion line for a turbine working with a hydraulic efficiency η_i. The total area of the diagram is in this case larger than before, because the energy wasted in friction, being returned to the steam as heat, makes the volume at every point of the stroke more than if unit efficiency were attained. On this larger diagram, however, only the fraction η_i is recovered as useful work on the shaft, whereas in the ideal case of unit efficiency the useful work done is represented by the whole of the area $ABDC$. In all cases $\eta_i \times ABEC$ is less than $ABDC$.

The efficiency ratio ε of the turbine is equal to the actual work done divided by that theoretically due from a perfect turbine, or

$$\varepsilon = \eta_i \frac{ABEC}{ABDC}$$

and the reheat factor R is defined by the relation

$$R = \frac{ABEC}{ABDC}$$

so that $\varepsilon = \eta_i R$, where η_i is known as the hydraulic efficiency of the turbine.

The actual thermodynamic head under which any turbine works is therefore not represented by the adiabatic heat drop u, but by a larger quantity U, where $U = Ru$.

From this the writer proceeds to show how to determine the value of the reheat factor corresponding to different values of the hydraulic efficiency of the turbine and comes to the expression

$$R = \frac{1}{\eta_i} \cdot \frac{1 - \left(\frac{1}{x}\right)^{\eta_i[1-(1/\gamma)]}}{1 - \left(\frac{1}{x}\right)^{[1-(1/\gamma)]}}$$

where η_i is the hydraulic efficiency of the turbine and x the ratio of the initial to the final pressure. From this he derives the values of the reheat factor for superheated steam throughout the whole range of its expansion for the various hydraulic efficiencies given in Table 2.

In other words, the efficiency ratio of a turbine is defined as the product of its hydraulic efficiency and the reheat factor.

In view of its use elsewhere in this discussion attention is called to the following expression for λ:

$$\lambda = \frac{1 + \frac{1}{\gamma - 1}}{\frac{1}{\gamma - 1} + k}$$

where γ is the index when the expansion is adiabatic.

Among other things the writer calls attention to the paradox following from the above expression for the reheat factor R. If the expansion be carried far enough, the efficiency ratio is independent of the hydraulic efficiency which can be shown by making $x = \infty$. Since then the efficiency ratio is equal to $R\eta_i$, its value is always unity if the expansion be carried to zero pressure. The following physical explanation is given: To reduce the final pressure to zero we must go down to the absolute zero of temperature. In deducing the value of R it was assumed that all the heat energy not expended in doing useful work was restored to the fluid in the form of heat. At the absolute zero of temperature the working fluid retains no heat energy and the latter has accordingly all been turned into useful work and the efficiency ratio is unity, however great the frictional losses may have been at each stage of the turbine.

The writer points out that the error in reheat factors for wet or saturated steam is considerable, because for the adiabatic expansion of such steam in thermal equilibrium the expression of the form $pV^n =$ constant (where $n = \gamma$), is only moderately accurate. In such a case the reheat factor may be determined in

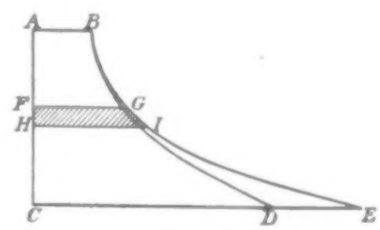


Fig. 1 Ideal Indicator Diagram for Steam Turbine

another way, published in *Engineering* several years ago. The writer repeats the argument presented there and gives a table

TABLE 2 REHEAT FACTOR FOR STEAM SUPERHEATED THROUGHOUT THE WHOLE RANGE OF ITS EXPANSION

Values of $x = \frac{p^0}{p^1}$	Hydraulic Efficiency η			
	0.5	0.6	0.7	0.8
1	1.0000	1.0000	1.0000	1.0000
2	1.0393	1.0312	1.0235	1.0160
4	1.0753	1.0629	1.0463	1.0310
6	1.1033	1.0809	1.0602	1.0397
8	1.1195	1.0934	1.0695	1.0454
10	1.1310	1.1024	1.0762	1.0494
15	1.1554	1.1209	1.0891	1.0585
20	1.1691	1.1313	1.0964	1.0617
25	1.1841	1.1445	1.1057	1.0692
50	1.2219	1.1718	1.1253	1.0810
100	1.2586	1.1998	1.1450	1.0932
200	1.2962	1.2279	1.1643	1.1053

showing the value of reheat factor for steam unusually dry and expanding in thermal equilibrium throughout, that is to say, with no undercooling, a condition which is, however, not realized either in a steam turbine or in a reciprocating engine. These values are given in Table 3.

The writer makes the following comparison of Tables 2 and 3. Suppose a steam turbine designed to give a hydraulic efficiency of 0.7 for the range of expansion of from 200 lb. absolute down to 1 lb. absolute. Then if the steam supply is saturated and the expansion takes place in thermal equilibrium throughout, its thermodynamic efficiency ratio will, from Table 3, be $0.7 \times 1.0559 = 0.739$ nearly. If, on the other hand, the turbine is designed to give the same hydraulic efficiency with steam supplied at 200 lb. and superheated to such an extent that the superheat is not lost when the exhaust port is reached, the efficiency ratio will be $0.7 \times 1.1643 = 0.815$ nearly. Hence, with the same hydraulic efficiency the thermodynamic efficiency ratio will be fully 10 per cent more with superheated than with saturated steam expanding in thermal equilibrium.

It will be obvious, therefore, that the adiabatic heat drop forms a somewhat fallacious foundation for estimating the saving to be effected by superheating the steam.

The writer shows next how to determine the point at which different degrees of initial superheat are lost. Assume for example that the initial pressure is 180 lb. absolute and that the

hydraulic efficiency of the turbine is 70 per cent. Suppose the superheat to be lost at, say, 80 deg. cent. The volume of the steam

TABLE 3 REHEAT FACTORS R FOR STEAM INITIALLY IN THE DRY BUT SATURATED CONDITION, AND EXPANDED FROM DIFFERENT INITIAL PRESSURES DOWN TO 1 LB. ABSOLUTE, THERMAL EQUILIBRIUM BEING MAINTAINED THROUGHOUT THE EXPANSION

Abs. Initial Pressure, lb. per sq. in.	Abs. Final Pressure, lb. per sq. in.	Hydraulic Efficiency η				
		0.5	0.6	0.7	0.8	0.9
2	1	1.0085	1.0078	1.0065	1.0046	1.0022
4	1	1.0191	1.0163	1.0129	1.0089	1.0043
6	1	1.0284	1.0217	1.0169	1.0114	1.0056
8	1	1.0316	1.0256	1.0195	1.0130	1.0062
10	1	1.0355	1.0290	1.0221	1.0148	1.0071
15	1	1.0435	1.0348	1.0264	1.0181	1.0078
20	1	1.0496	1.0394	1.0294	1.0191	1.0088
25	1	1.0537	1.0427	1.0318	1.0210	1.0104
50	1	1.0669	1.0531	1.0394	1.0261	1.0129
100	1	1.0809	1.0640	1.0475	1.0313	1.0155
200	1	1.0956	1.0755	1.0559	1.0368	1.0162

is then 54.596 cu. ft. per lb. (Callendar) and its pressure is 6.8627 lb. per sq. in.

The initial pressure being 180 lb. absolute, we have

$$x = \frac{p_1}{p_2} = \frac{180}{6.8627}$$

If ρ be the ratio of the final volume to the initial volume then, since the expansion follows the law $pV^m =$ constant (where $m = \lambda$), we have $\rho = x^1/^m$

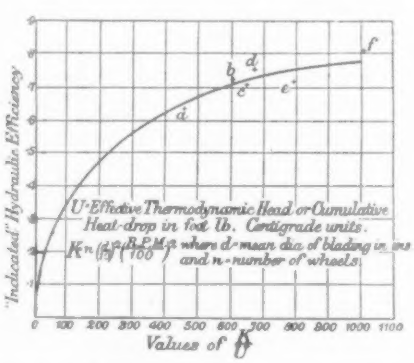


FIG. 2 "INDICATED" HYDRAULIC EFFICIENCY OF IMPULSE TURBINES IF STEAM EXPANDS IN THERMAL EQUILIBRIUM THROUGHOUT

The value of $1/m$ is given (*Engineering*, July 19, p. 53) by the relation

$$\frac{1}{\lambda} = 1 - 0.23077\,\eta_t = 1 - 0.23077 \times 0.7 = 0.8385$$

Whence

$$\rho = \left[\frac{180}{6.8627}\right]^{0.8385} \quad \text{and} \quad V_2 = \frac{V}{\rho} = 3.528 \text{ cu. ft. per lb.}$$

Reference to Callendar's table shows that steam at 180 lb. absolute with this specific volume has a temperature of 331.6 deg. cent., corresponding to a superheat of 142.1 deg. cent. or 255.8 deg. fahr. By determining a number of values in this way and plotting the results as curves, the temperature at which any stated initial superheat is lost can be determined. The writer gives a table showing the approximate centigrade temperatures at which superheat is lost for different hydraulic efficiencies when the initial pressure is 180 lb. absolute. With the temperatures given in such a table it is possible to calculate the total effective thermodynamic head, or, to use Professor Goudie's term, the "cumulative heat" which becomes available in a turbine when expanding steam from 180 lb. absolute to 1 lb. absolute with different hydraulic efficiencies, the steam being supposed to be in thermal equilibrium throughout. The writer gives a table of cumulative available heats when steam expands in thermal equilibrium from an initial absolute pressure of 180 lb. per sq. in. to 1 lb. absolute with different hydraulic efficiencies and different initial superheats. This table is here reproduced as Table 4. To determine from this table the theoretical steam rate for a turbine working with different superheats a correction is required because increases in the effective thermodynamic head change the ratio of blade speed to steam speed.

This correction can be effected by means of the curve plotted in Fig. 2 on the assumption that thermal equilibrium was maintained throughout the whole expansion. In this curve the "indicated" hydraulic efficiency of a number of impulse turbines is plotted against K/U, where

$$K = n\left(\frac{d}{10}\right)^2\left(\frac{\text{R.P.M.}}{100}\right)^2$$

and U denotes Ru, where u is the adiabatic heat drop. In the above expression for K the number of stages is represented by n, while d denotes the mean diameter of the blading. Since the average velocity of the steam is proportional to $\sqrt{(U/n)}$, the expression $\sqrt{(K/U)}$ is proportional to the ratio of blade speed to steam speed. According to the ordinary view the indicated hydraulic efficiency should give a parabola when plotted against

TABLE 4 CUMULATIVE AVAILABLE HEATS F. P. C. WHEN STEAM EXPANDS IN THERMAL EQUILIBRIUM FROM AN INITIAL ABSOLUTE PRESSURE OF 180 LB. PER SQ. IN. TO 1 LB. ABSOLUTE; WITH DIFFERENT HYDRAULIC EFFICIENCIES AND DIFFERENT INITIAL SUPERHEATS

Hydraulic Efficiency η	Initial Superheats, Deg. Fahr.						
	0	50	100	150	200	250	300
0.5	201.3	207.2	216.2	226.9	238.9	251.1	262.4
0.6	197.4	203.5	210.3	219.4	229.6	240.4	251.4
0.7	194.1	199.2	206.7	214.2	222.6	232.9	241.3
0.8	190.7	196.3	202.5	209.3	216.9	228.5	233.6
1.0	184.1	189.5	195.4	201.7	208.2	215.0	222.0

$\sqrt{(K/U)}$, and consequently the curve in Fig. 2 should be an ellipse. The points lie badly on an ellipse, however, and the curve shown has been sketched in freehand. As will be shown later, a much better agreement between the curve and the experimental figures is obtained when the theory that the steam expands in thermal equilibrium is abandoned.

The writer proceeds to a discussion of the results in this case and compares them with the data on Baumann's correction curves. Altogether it is found that consumption with saturated steam, assuming that the expansion takes place in thermal equilibrium, should be 1.077 times as much as with steam superheated to 150 deg. fahr., but from a table given in the original article it appears that the actual consumption of superheated steam is 1.163 times as much, which would indicate that the known values of the superheat corrections are inconsistent with the hypothesis that the expansion of wet steam takes place in conditions of thermal equilibrium.

It might be said that this discrepancy is due to the higher frictional resistance which wet steam meets, but this is at variance with an observation made by Osborne Reynolds to the effect that when the motion of fluid is such that resistance is as the square of the velocity, the magnitude of this resistance is sensibly quite independent of the character of the fluid in all respects except that of density. This view has received ample experimental confirmation, for instance, in the work of Prof. C. H. Lees. The viscosity has only a small influence on the flow phenomena and it does not appear that any material difference can be due, as far as fluid friction is concerned, to water steam if superheated or wet.

While it has been known for a long time that the assumption that wet steam was in thermal equilibrium throughout the whole of its expansion is erroneous, opinions have differed as to the importance of the consequent loss from undercooling. The most

general opinion has been that once the supersaturated steam began to condense, thermal equilibrium was practically instantaneously restored and was maintained during any specimen expansion. The writer attempts to prove that this theory does not explain the observed values of the superheat corrections.

The fact that nozzles fed with wet steam discharge a greater weight than can be accounted for on the ordinary theory has been traced to supersaturation of the steam as it passes the nozzle throat, a fact which has been confirmed experimentally by Dr. Stodola.

In this connection, it is mentioned that in Stodola's tests where ordinary boiler steam was led directly to the nozzle a cloud of spray was visible close up to the nozzle discharge, but the presence of a spray does not necessarily prove the absence of undercooling. In the first place, it is known by experiment that a nozzle will pass a greater weight of ordinary boiler steam than would be possible with undercooling absent. Further, the drops of water present cannot cool quickly even to serve as nuclei of condensation. Professor Callendar has obtained evidence of undercooling in the cylinder of an ordinary reciprocating engine where the rate of expansion is very much slower than in a turbine, a fact confirmed by other observations cited by the writer. In this connection the writer cites Lord Kelvin's theory of evaporation of drops, one of the conclusions of which is that in no case can a drop of pure water be in equilibrium with steam of the same temperature, and the fact the droplets are observed to proceed even in the mist of superheated steam is due to the fact that such drops are not drops of pure water, but have arisen from priming containing dissolved salts and thus have a lower vapor pressure than pure water.

An interesting calculation is given showing conditions in which a drop of pure water is in equilibrium with its surroundings. The final equation is

$$\log_e \frac{p}{p_s} = \frac{1}{R\,T} \cdot \frac{2\sigma}{r} \quad \ldots\ldots\ldots\ldots\ldots\ldots [1]$$

where p denotes the pressure in equilibrium with the drop of radius r and p_s the saturation pressure due to the temperature of the drop, σ the surface tension of the film expressed in dynes per cm., T the absolute temperature in degrees centigrade and R the constant in the ordinary gas equation. From experiments (C. T. R. Wilson) on dust-free but saturated air Callendar deduces that r is equal to 5×10^{-8} cm. This quantity is of molecular dimensions, and it is natural to conclude that the nuclei involved are the double or co-aggregated molecules which are known to exist in steam, and in truly stupendous numbers, presenting in the aggregate an enormous surface. It is not suggested that these co-aggregated molecules are actually spherical in form, but merely that considered as nuclei they are equivalent to spheres of the radius stated.

In the present connection, however, the important fact is that r is constant, so that Equation [1] may be written as

$$\log_{10} \frac{p}{p_s} = \frac{3.75\,\sigma}{T}$$

and the writer gives rather complicated formulæ for σ. Table 5 gives the values of p/p_s for different temperatures.

Table 5 shows that if steam is expanded until a temperature falls, say, to 40 deg. cent., there will be no condensation of steam unless the pressure is 6.987 times that of a saturated steam at the same temperature. This fact is sometimes expressed by the statement that the density of supersaturated steam when on the verge of condensing at 40 deg. cent. is about 7.5 times as much as it ought to be, which is misleading as it is apt to convey the impression that the specific volume of supersaturated steam is inly 1/7.5 of what it would be had expansion taken place in conditions of thermal equilibrium, which is not true. Actually at 40 deg. saturated steam has a pressure of 1.0703 lb. per sq. in., and therefore no condensation will occur unless the pressure of the steam exceeds $6.787 \times 1.0703 = 7.478$ lb. per sq. in.

From the values of p/p_s in Table 5 one can find the pressure at which supersaturated steam at different temperatures condenses, and from Callendar's equations he can then get both the corresponding volume of the steam before the condensation occurs and also its total heat, likewise the entropy of the steam just before the condensation occurs, which, in its turn may be used for plotting the Wilson line of the steam chart and the cumulative heat drop or effective thermodynamic head due to an expansion without condensation down to the Wilson line and with the subsequent expansion in conditions of equilibrium.

TABLE 5

t	$\frac{p}{p_s}$	t	$\frac{p}{p_s}$	t	$\frac{p}{p_s}$
0	11.08	40	6.987	80	5.014
10	9.727	50	6.367	90	4.685
20	8.632	60	5.841	100	4.300
30	7.732	70	5.395	110	4.152

The writer proceeds to prove by a very interesting calculation that the thermal equilibrium of expanding steam cannot be immediately reëstablished when condensation takes place at the Wilson line. In fact, Wilson found that the number of droplets formed in his experiments on the expansion of supersaturated vapor increased enormously when the expansion was continued beyond the Wilson point, which indicated that the condensation was occurring not on the droplets already formed, but on new nuclei, and the temperature of the expanding vapor must accordingly have been not higher than that of the Wilson point corresponding to the pressure. There was thus a high degree of undercooling up to the very end of the expansion, but the temperature of this undercooled steam cannot be measured by means of a thermometer, as is shown elsewhere by the present writer.

This is followed by a discussion of the mechanics of condensation of vapor. The vapor condenses because of the mutual attraction between its molecules. This attraction is electrical in origin and essentially similar to that which operates in the formation of chemical compounds. Heat is a molecular motion and is subject to the general laws of transference of energy which occurs only slowly when the energy goes from the light electron to the heavy molecule. Until this transfer is effected the energy involved does not appear as heat. It has been shown above that the assumption that the steam expands in thermal equilibrium when the expansion is carried beyond the Wilson line is inconsistent with experience, which is thus in accord with Wilson's observation that the condensation which comes down during such an expansion separates on fresh nuclei. For this comparison the curve for Fig. 3 will be used. Many of the results plotted in the earlier portion of this curve were obtained in progressive trials of a steam turbine run at different speeds and with different superheats. The steam was highly superheated so that the "indicated" efficiencies could be determined without various corrections for dummy and gland leakages and for frictional losses which make the calculation of "indicated" efficiencies of a turbine so difficult in usual tests. Other points are plotted from ordinary test data corrected for internal losses. Some of the points, however, are erratic. On the whole, the curve is believed to represent fairly accurately the relative efficiency of turbines as the ratio K/U is increased.

The value of U adopted was calculated from the writer's modification of Callendar's steam chart using the equivalent reheat factors for expansions beyond the Wilson line, and he describes in considerable detail how these equivalent reheat factors were arrived at. The values of these equivalent reheat factors for various hydraulic efficiencies of the turbine are given in a table in the original article.

The term "equivalent reheat factor" can be understood from the following discussion. It is a fundamental axiom in thermal dynamics that a gas by suitable addition of heat may be caused to expand according to any law however arbitrary. It is thus possible, for example, by the use of appropriate reheat factors to make the volume and pressure of steam expanding without condensation exactly the same point for point as the volume and pressure of wet steam expanding, in conditions of thermal equilibrium. The gross work done in this "equivalent" expan-

sion is the same as that done in the corresponding actual expansion of the wet steam.

Thus, when wet steam expands in conditions of thermal equilibrium the actual volume occupied by the steam depends upon the dryness fraction. Nevertheless, the relation between volume and pressure can be represented with considerable accuracy by an expression of the form $pV^n =$ constant. If at starting the steam is just dry, then according to Zeuner the expansion takes place according to the law $pV^{1.135} =$ constant, and by the methods elsewhere explained in this paper one can calculate a series of reheat factors, which, when applied to superheated or completely supersaturated steam, will give the same law of expansion.

The difference between real expansion and "equivalent" lies in the following: In the first place, the useful work done and the relation between volume and pressure for the actual expansion in thermal equilibrium can, by the use of appropriate reheat factors,

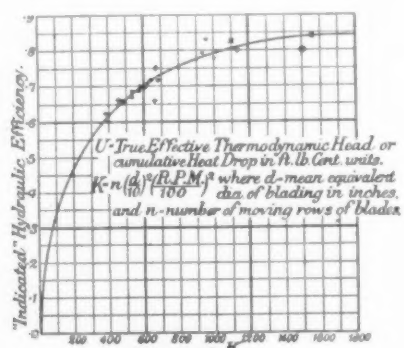


FIG. 3 "INDICATED" HYDRAULIC EFFICIENCY OF REACTION TURBINES

(Not corrected for leakage over blade tips.)

be represented by an expansion between the same limits of steam which remains completely supersaturated.

Next in the real expansion the volume occupied by the steam is diminished owing to condensation: in the equivalent expansion this real defect in the mass, actually gaseous, is replaced by an equivalent but imaginary reduction in the mass which is assumed to remain wholly in the state of vapor.

The writer then proceeds to the calculation of relative consumptions on the basis of the curve in Fig. 3 on the assumption that the steam behaves throughout as if completely superheated, which indicates the true value of the reheat factor.

From this the writer proceeds to the consideration of vacuum corrections. That the vacuum corrections are quite irrational on the ordinary theory has long been recognized, as in this theory with high-pressure turbines a reduction of the exhaust steam from 1 lb. absolute to ½ lb. absolute should reduce the consumption by some 11 per cent; whereas, experience shows that the actual improvement in the steam rate is from 5 to 6 per cent.

In this connection the writer discovered that the real discrepancy is somewhat less than these figures would imply, as no allowance has been made for the fact that the increase of vacuum involves an increase in the total effective thermodynamic head. Furthermore, the effective change in the vacuum is strictly local and materially affects only the last row of blades.

Thus, in a certain impulse turbine designed so that with normal vacuum the velocity of efflux from the last row of guide blades is slightly above the critical value, which is the speed of sound, the "use" of an important increase in the vacuum can never get back past the last row of nozzles and it is only the last wheel of the turbine that can ever get to "know" that the vacuum has been increased.

Since the whole effect of the increase of vacuum is concentrated on the last stage where both the axle and the wheel efficiencies will be reduced, the total resultant loss of efficiency of the turbine as a whole will be greater than if the increase in the thermodynamic head had been equally divided between all its stages.

The writer proceeds from this to the calculation of vacuum corrections, first considering the turbine as being operated for water and then by steam. This part of the paper, while brief, is of considerable interest as giving a clear idea of the method used by the writer, and is strongly recommended to the attention of those who can spare the time to read over the original article.

The following recapitulation of the new theory is given by the writer himself: Starting from the now accepted view that wet steam is not discharged from a nozzle in a condition of thermal equilibrium, reasons have been given for believing that in actual turbine practice, the expansion of wet steam never does occur in a condition of thermal equilibrium. Evidence of this is afforded by the condition of the steam in the exhaust branch of a turbine, where temperature measurements do not correspond with the pressure of the steam as simultaneously observed. True, the apparent defect of temperature is small, but it has been pointed out that the kinetic theory of gases requires that the readings of a thermometer immersed in undercooled steam should correspond to the pressure rather than to the temperature of this steam. That the true defect of temperature may amount to many degrees, may, it is pointed out, be inferred from Wilson's experiments on the expansion of supersaturated vapor, where, when the expansion was continued beyond the point at which moisture first separated out, the additional condensation came on new nuclei, and these new nuclei can be effective only when the defect of temperature amounts to some tens of degrees.

It was shown that on this hypothesis a rational explanation of the anomalies in superheat and vacuum corrections became possible, thus bringing theory into accord with actual experience. (*Engineering*, July 5 and 19, August 2, 9 and 23, and September 6, 1918; compare also THE JOURNAL of The American Society of Mechanical Engineers, September, October and November, pp. 784-787, 871-872 and 965-966.)

The Harvard School of Engineering has been reorganized and its courses were opened to students on January 1, and will continue during the Summer to enable the entrants to complete a full year's work by the opening of the next academic year in September. Some time ago, says the New York *Times*, Harvard University and the Massachusetts Institute of Technology agreed to combine effort in engineering instruction, making use of funds provided under the will of the late Gordon McKay. The agreement was objected to and the Massachusetts Supreme Court held that the arrangement was not in accord with the provisions of the will. The new arrangement has been approved both by the trustees of the McKay estate and by the governing boards of the university.

The instruction will be carried on entirely by a Harvard faculty, appointed by the university governing boards, and students who satisfactorily complete four years of study will receive the degree of bachelor of science. Higher degrees will be granted after additional study. Generally speaking, the work will be carried on in the classrooms and laboratories of the university, but arrangements may be made, from time to time, to utilize the facilities of other institutions, especially in the advanced technical courses. Instruction will be offered in mechanical engineering, civil engineering, sanitary engineering, electrical engineering, mining and metallurgy, and industrial chemistry.

It is provided that all grades of instruction, "from the lowest to the highest," shall be offered and shall "be kept accessible to pupils who have had no other opportunity of previous education than those which the free public schools afford." Requirements for admission to the school will be the same as those for admission to Harvard University. Admission to advanced standing and special study will be administered by the Engineering faculty.

The fees will be the same as those of the university, except that supplementary fees for additional or for laboratory courses may be charged. When funds from the McKay endowment are available, in the judgment of the President and Fellows, for the construction of new buildings for the Engineering School, such buildings will be constructed on Harvard University grounds and will bear the name of Gordon McKay.

THE PRODUCTION OF HELIUM FROM NATURAL GAS

Abstract of Address by Dr. Frederick G. Cottrell Reviewing Recent Work in the Liquefaction and Separation of Gases and the Production of Helium for Use in Balloons

On Friday evening, January 17, 1919, at the Chemists Club, the Society of Chemical Industry, the American Chemical Society and the American Electrochemical Society awarded the Perkin Medal to Dr. Frederick G. Cottrell, Chief Metallurgist of the Bureau of Mines. The medal was presented by Dr. Charles F. Chandler, senior past-president of the Society of Chemical Industry.

In accepting the medal, Dr. Cottrell spoke briefly on the subject of electrical precipitation and the patent situation leading up to the formation of the Research Corporation and its work in this and allied lines. He outlined the bill which has been introduced in both the Senate and House of Representatives at the instance of Secretary Lane of the Department of the Interior, authorizing the Federal Trade Commission to administer such patents as may be tendered to it by Government employees and others. This latter body has, during the war, been administering enemy-owned patents in much the same manner, and therefore already has the machinery and experience needed.

No matter how potentially valuable a purely scientific discovery is, it seldom benefits the public at large until it is carried through to industrial and commercial development and connects with the well-established avenues of trade. It is particularly in the case of patents on broad, fundamental projects that such an administration is of most importance.

The chief interest in the address, however, attaches to that portion which relates to the liquefaction and separation of gases and the final production, probably on a commercial scale, of the non-inflammable and buoyant gas, helium, for use in dirigible and observation balloons. It is mainly through Doctor Cottrell's work both as a scientist and in an administrative way that this has been brought about. The development came through investigations by him and others of the possibility of producing industrial oxygen at low cost by the liquefaction and distillation of air and in the application of similar principles to the production of helium from natural gas. Three development plants for this purpose are now in operation in Texas.

In the course of his remarks Doctor Cottrell referred to the recent address in New York by General Squier, Chief Signal Officer of the U. S. Army, in which the latter said that the production of helium had been so cheapened that it could now be produced at 10 cents a cu. ft. instead of the prohibitive price of \$1700 a cu. ft., which was the cost only two years ago; and in commenting, Dr. Cottrell said that if present expectations are fulfilled this cost may be still further reduced. He also emphasized the possibilities of the commercial production of oxygen for metallurgical work by the development of air-separation processes.

In this work a considerable number of well-known scientists and engineers have been engaged, including, among others, the following members of this Society: Fred E. Norton and E. A. W. Jefferies, of Worcester, Mass.; O. P. Hood, of the Bureau of Mines; Dr. Edgar Buckingham, of the Bureau of Standards, and George A. Orrok, of New York.

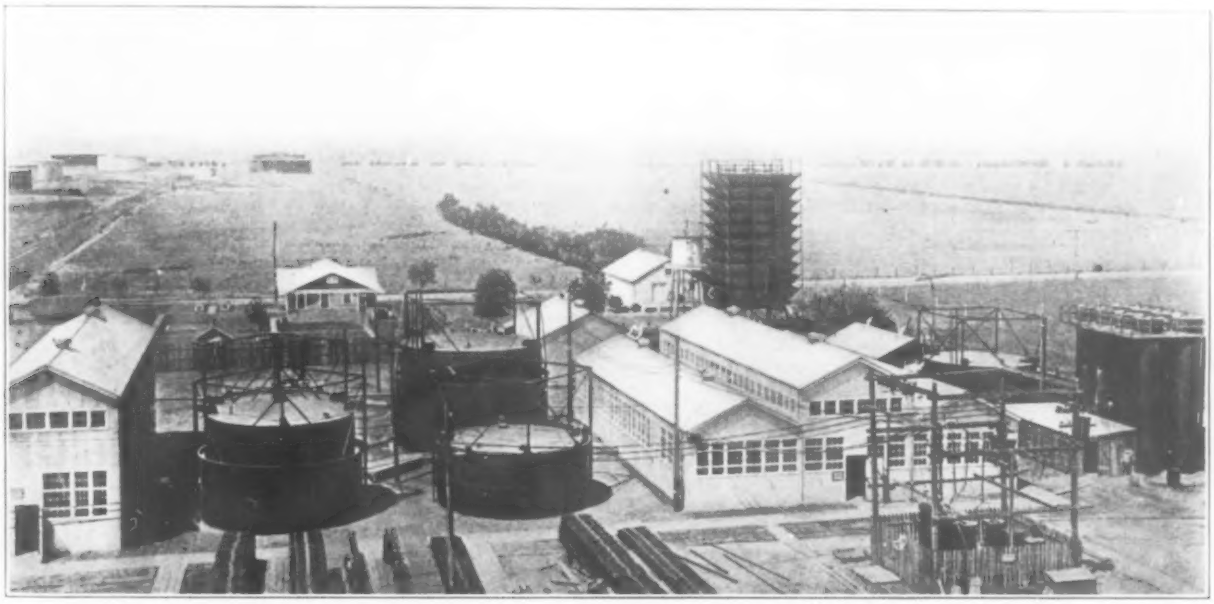


Fig. 1 U. S. Bureau of Mines Experimental Plant No. 1, at North Fort Worth, Texas

The following summarizes Doctor Cottrell's remarks:

Air Separation and Liquefaction of Oxygen

In 1904, in operating a liquid-air plant of the Hampson type at the University of California, I became greatly impressed with the ultimate possibility of producing very cheap industrial oxygen, but was equally impressed with the very crude thermodynamics which all the systems then common represented from an engineering standpoint. On assuming charge of the Metallurgical Division of the Bureau of Mines in 1916, I felt that the quest for cheap oxygen had become more than ever a large and legitimate part of my regular work; but, realizing my own limitations and the Bureau's inadequacy of material facilities, I strove to suggest, stimulate and collect inventions and developments rather than attempt to originate anything in this highly technical field.

Oxygen as sold today in steel cylinders is so expensive that it usually fails to suggest even faintly the ultimate possibilities for low-cost production, whereas on the very large scale, where unit cost of plant, overhead, sales expenses and the like are greatly reduced and compression into cylinders, transportation of the cylinders, etc., are completely eliminated, we come down to the power consumption for the actual separation as the largest and dominant factor of ultimate cost.

The final measure of theoretical efficiency is, of course, the degree to which reversibility in the thermodynamic sense has been

approached. Air is only a mixture and not a chemical compound of oxygen and nitrogen, and, therefore, no energy has to be supplied in its separation to overcome chemical affinity, but we do have to overcome what we may call the force of diffusion of the two gases in effecting their separation. In other words, we have to deal purely with that elusive second law of thermodynamics and not with the first. Thus, figured mechanically, the work necessary to separate five volumes of air at atmospheric pressure into one volume of oxygen and four volumes of nitrogen, each at atmospheric pressure, is equal to that necessary to compress the oxygen from the five volumes at 1/5 atmosphere to one volume at one atmosphere plus that to compress five volumes of nitrogen at 4/5 atmosphere into four volumes at one atmosphere, all isothermally.

In more practical engineering terms, the mechanical work necessary to separate a given amount of air into its components, oxygen and nitrogen, all at atmospheric pressure, is equivalent to that necessary to raise the same amount of air isothermally to a pressure of 9.8 lb. per sq. in. above atmospheric pressure. This figures out about 60 hp-hr. per ton of oxygen separated, or with adiabatic compression about 66 hp-hr. This is, of course, the theoretical limit for a perfect reversible cycle, which cannot be attained in practice, but we may hope to approach it to much the same degree that we have the corresponding limit in the steam engine and the air compressor, say 50 per cent as at least a legitimate goal for early endeavor. It seems doubtful whether any large-scale air-separating plants at present in service are greatly exceeding 10 per cent.

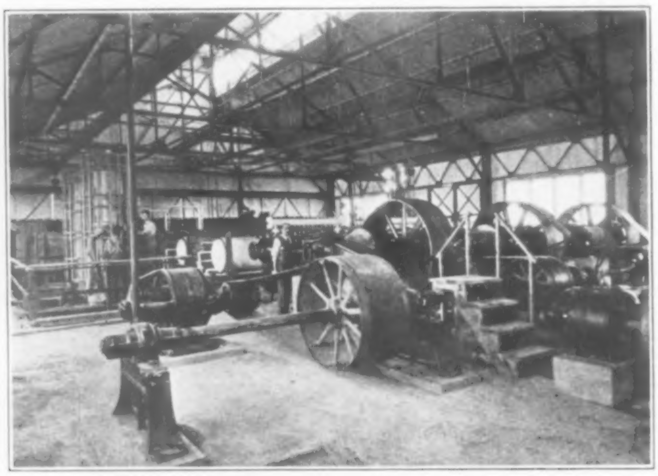


FIG. 2 INTERIOR, U. S. BUREAU OF MINES, PLANT NO. 3, J-N SYSTEM, PETROLIA

It was in March, 1916, that Director Manning of the Bureau of Mines handed me a memorandum of a conversation he had chanced to have in New York with some business men concerning a new process for air separation. The information it contained was more amusing than instructive, and I filed it with similar "clues to great inventions," and later investigated it. The trail led me back, with some little winding, to Mr. Fred E. Norton, Mem.Am.Soc.M.E., of Worcester, Mass., a graduate of '91 of the Massachusetts Institute of Technology. He had, in 1913, in connection with Mr. E. A. W. Jefferies, Mem.Am.Soc.M.E., undertaken the engineering development of a process of air separation patented by the latter and which he had made arrangements with the General Chemical Company to try out at one of their plants. Considerable work had been done when the General Chemical Company dropped the matter and Messrs. Jefferies and Norton pooled their patents as the Jefferies-Norton process and continued experimental development in a smaller way.

SUGGESTION OF THE USE OF HELIUM FOR BALLOONS

A year earlier, but quite unknown to me, Dr. R. B. Moore, of the Bureau of Mines, who had worked with Sir William Ramsay, received under date of February 28, 1915, a letter from Sir William as follows: "I have been investigating blowers, i. e., coal-damp rushes of gas for helium for our Government. There does not appear to be any in our English blowers, but I am getting samples from Canada and the States. The idea is to use helium for airships."

The importance of this proposed use of helium for balloons, and particularly for airships of the Zeppelin type, lies in the absolute inertness and non-inflammability of helium and the fact that it is of all known substances the next lightest to hydrogen, having about 92 per cent of its buoyant effect. It also shows only about one-half the rate of diffusion and consequent wastage through the balloon fabric. As the fire hazard not only from incendiary bullets in war, but also from atmospheric electricity and the power plant in both peace and war, has constituted the greatest drawback to the development of lighter-than-air craft, it is difficult to overestimate what an available supply of this gas may eventually mean in the art.

In a recent letter Dr. Moore says:

> Two or three weeks after war was declared, I attended a meeting of the American Chemical Society in Kansas City. At the general session Mr. Seibel, who had been working with Dr. Cady gave a paper on krypton and xenon in some of the natural gases of Kansas. At the end of his paper he expressed regret that at such a time, when every one was thinking of war problems his paper was of a purely scientific nature and had no practical bearing on the war. I immediately got up and said that I did not agree with Mr. Seibel; as the presence of helium in these wells could, and should, have a very practical bearing on the war; as this gas could be extracted in quantity from the natural gas and used for balloons and Zeppelins. I pointed out some of the natural advantages of helium over hydrogen, and quoted Sir William Ramsay's letter. The general attitude of those present was one of skepticism. The same day I talked to Dr. Parsons who was present at the meeting and who was returning to Washington almost immediately. I told him what had happened and told him that I believed the matter should be taken up by the Bureau at once, and presented to the War Department. He promised that he would do this as soon as he got to Washington and I know that he did take the matter up with other Bureau officials.

News of Ramsay's suggestions also reached this country through other channels and were later called to our attention. Col. G. A. Burrell, who headed the Research Department of the Gas Warfare Service at the American University, tells me that Cady's experiments had also suggested similar possibilities to him.

On June 1, 1917, Doctors Moore and Burrell, both of the Bureau of Mines, called on Colonel Chandler, in charge of the Balloon Service for the Army, and explained the whole subject to him. He was intensely interested, at once realized its potentialities and asked that a report be made to him, giving all available details. He also took up the matter with Mr. G. O. Carter, in charge of hydrogen plants for the Navy, who had had several years' practical experience in the Linde Air Products Company with the liquefaction and separation of gases by their process. Mr. Carter also immediately appreciated the importance of the subject and urged this upon the attention of his superior officers.

REPORTS BY BRITISH ADMIRALTY AND U. S. BUREAU OF MINES

About this time I was called actively into the conference and was much impressed by the weight which the British Admiralty apparently laid upon the cost of separation of gas as a determining factor in its practical availability. They had figured this out on the basis of the well-known commercial processes of gas separation by liquefaction and separation and were unable to see how they could hope for production at less than \$60 to \$80 per 1000 cu. ft., which they felt to be practically prohibitive.

It was at this stage that I suggested turning to Mr. Norton at least for a plan and estimate of what he thought might be accomplished along the new lines he had been following. On Monday, June 4, with Mr. T. B. Ford, then in charge of the Low-Temperature Laboratory at the Bureau of Standards, and Mr. O. P. Hood, Mem.Am.Soc.M.E., Chief Engineer of the Bureau of Mines, we spent the whole day in thrashing out the whole subject with Mr. Norton. As a result Mr. Norton was asked to act as a consulting engineer of the Bureau of Mines and prepare plans and estimates for an experimental plant.

In due course a formal report was made by the Bureau of Mines to the Army, and although this was as yet fragmentary and based on very inadequate data concerning the practical conditions to be met, the Aircraft Board recommended on July 31, 1917, an appropriation of $100,000, half each from the Army and Navy, which became available for the use of the Bureau of Mines on August 4.

A detailed survey of field conditions, to determine the best available supply of natural gas for the purpose, was at once begun by Dr. H. B. Cady, as was also the preparation by Dr. Norton of working drawings for the experimental separation plant.

Mr. Burrell next communicated with the two well-established operating companies controlling, respectively, the Linde and Claude systems of gas liquefaction and distillation, to determine whether it would be possible to work out a plan for pooling of information and facilities for this specific war purpose. Due to the questions of trade secrets and business relations, this did not, however, prove possible, though both companies expressed themselves as entirely willing to undertake independent efforts and the erection of plants of their own respective designs at cost, or even less, and have ever since most cordially furnished every facility in their power to make the work as a whole a success.

Construction of Linde, Claude and Norton Plants

Further appropriations of $500,000 and $100,000 were made by the Aircraft Board and contracts were entered into with the Linde Air Products Company and the Air Reduction Company for the Linde and Claude plants respectively, each for an estimated daily production of about 7000 cu. ft. of helium.

Some doubt remained in the minds of the Government officials regarding the Norton process and the Secretary of the Navy, feeling the need of further outside advice in the matter, requested the National Research Council to investigate the project with special regard to its theoretical soundness and also its apparent chances for practical success.

The Council appointed for this purpose a committee of five, consisting of Prof. H. N. Davis of Harvard, Dr. Edgar Buckingham, Mem.Am.Soc.M.E., and Chas. W. Waidner of the Bureau of Standards, Dr. W. F. Landis of the Air Nitrates Corporation, and Mr. S. L. G. Knox, consulting mechanical engineer, and recently Scientific Attaché to the American Embassy at Rome. This committee, after very careful comparative study of the three processes, concurred in the Aircraft Board's recommendation of the additional $100,000, which was then immediately made available by the Army and Navy.

These plants were to be located at North Fort Worth, Texas, and operate on a natural gas containing about 0.9 per cent helium by volume, of which the Lone Star Gas Company was bringing some 20,000,000 cu. ft. daily through its pipe lines from the wells at Petrolia, about 100 miles northeast of Fort Worth to that city for domestic and industrial consumption.

It was decided to locate the Norton plant at Petrolia in direct proximity to the wells, a procedure which had not been deemed practicable for the other two plants on account of their larger demands for power and water supply.

In order properly to coördinate all the different agencies concerned, the conduct of the helium work as a whole was about this time placed in the hands of a committee consisting of one representative from each of the departments chiefly concerned. Mr. G. O. Carter, Chairman, represented the Navy, Dr. H. N. Davis the Army, and Mr. Geo. A. Orrok, Mem.Am.Soc.M.E., the Interior.

The Linde plant, costing in round figures $300,000, was the first to be contracted for and have its construction started. It produced the first helium on March 1, 1918, and by September 6 had increased its yield to 7750 cu. ft. per day of 67 per cent purity, which was later repurified to about 92 per cent.

The Claude plant, costing about half as much as the Linde, commenced production some weeks later than the latter and has also gradually increased its production and purity of products.

At the time of signing the armistice the first shipment of 147,000 cu. ft. of 93 per cent helium was on the dock about to be loaded aboard ship for Europe.

Fig. 1 shows the Linde plant at North Fort Worth and Fig. 2 the Bureau of Mines' experimental station containing the Jefferies-Norton plant at Petrolia.

The Army and Navy have now jointly entered upon a larger production program under the immediate direction of the Navy and have allotted some $5,000,000 for the construction of a new pipe line and additional units of the Linde plant at Fort Worth.

A large part of the credit for the promptness with which this actual production was effected is due to Mr. Carter who was tireless in his efforts in pushing matters of priority, transportation, construction and production.

The Norton, or Bureau of Mines, plant at Petrolia was completed as far as initial construction is concerned the middle of October, and since that time has been undergoing tests and adjustments of its various parts. The multi-tubular heat interchangers and large expansion engines, which were among the new departures in this plant, have worked out very well and now seem to be performing their allotted tasks to complete satisfaction. A good deal of difficulty was at first encountered by occasional floods of oil and salt water coming over from the Lone Star Gas Company's gasoline-extraction plant, which clogged up the interchangers, making it necessary to shut down and go through the laborious process of thawing out the whole system and starting refrigeration afresh. This has now been eliminated by the installation of adequate settling chambers and traps, and tests and adjustments are proceeding upon the stills which form the last part of the equipment to be so tested. Temperatures as low as — 168 deg. cent. have since been attained in the Norton plant.

Cycles of Operation

At the conclusion of his address Dr. Cottrell showed by means of lantern slides the details of the various plants. We reproduce four diagrams from among these pictures showing the Ideal cycle, the Linde cycle, the Claude cycle, and the Norton cycle, and Dr. Cottrell has contributed a written description of the several processes for publication in Mechanical Engineering, which here follows: G. A. O.

DESCRIPTION OF CYCLES OF OPERATION

In studying the different systems of gas liquefaction and separation it is very essential at the outset to distinguish clearly between the production of liquid as an ultimate product and the utilization of liquefaction and reëvaporation as a mere step in a separation where the ultimate products desired are still gases and at essentially the temperature of the original mixture fed to the apparatus.

In the former case a very considerable expenditure of work is represented in what we may colloquially term the refrigerative properties of the liquid delivered.

But in the second case, where the liquid is not drawn off from the apparatus and its amount therein remains constant, the part continually evaporating serves to condense nearly an equivalent amount of the incoming gases. Also the cold gases furnished by this evaporation take up heat from and cool the fresh incoming gas while they themselves are returning to room temperature.

Ideal System

Thus, we may illustrate diagrammatically, as in Fig. 3,[1] the continuous process of liquefaction and reëvaporation of a single gas. Ideal conditions would consist in perfect heat interchange horizontally between the two legs of the U-tube A and C and perfect heat insulation lengthwise along each of these and from their surroundings.

If these conditions were fulfilled and the whole system once

[1] The four cuts here shown are from a report made in the early part of this work by Mr. Norton to Mr. Burrell, outlining the problem in hand and the relation of the three processes to one another as they appeared to him.

brought to a steady state by, let us say, refrigeration of the bottom of the U-tube by some extraneous source of initial cooling, while gas was slowly passed through it, we may imagine a certain amount of liquid condensed at the bottom of the U-tube and a uniform gradient of temperature established along its two legs. Now, if the initial extraneous source of refrigeration were re-

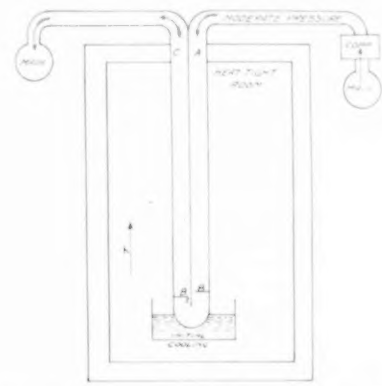


FIG. 3 IDEAL EQUAL-PRESSURE SYSTEM

moved, but gas still passed slowly into the system, the gas would progressively cool in A; liquefy at B; reëvaporate at B_2 and warm back to atmospheric temperature in passing up C. Under these ideal conditions, with a single gas, the slightest imaginable difference in pressure between A and C should serve to perpetuate the process.

Whatever heat leakage there is, however, either through the walls of the insulating chamber or down the legs of the U-tube, represents a loss not of energy itself but of its availability for the purposes in hand; i. e., of thermodynamic potential, or an

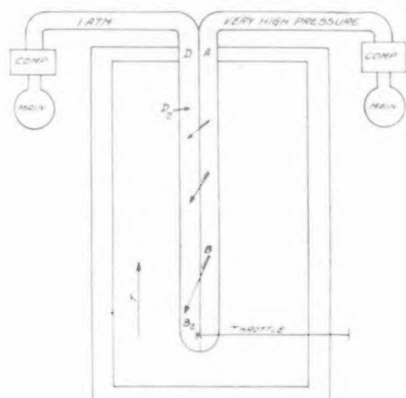


FIG. 4 LINDE SYSTEM

increase of entropy, if one prefers that terminology, the practical result being the necessity of expending mechanical work to compensate for these heat leaks. If, in addition to this, we are dealing with a mixture instead of a single pure gas, the constituents will in general liquefy and reëvaporate with varying ease, tending to set up temperature differences between adjacent parts of the two legs of the U and thus require a further expenditure of work to operate the cycle.

Looked at from the point of view of gas separation, the first of these effects represents pure loss, but the second is due, at least in part, to overcoming what we have above termed the force of diffusion in separating the gases and should thus be counted as useful work.

The problem is, therefore, to provide just enough refrigeration *at the proper temperature and places* to cover these two demands after they themselves are reduced to as low a value as possible in the design of the apparatus and by use of the best heat insulation attainable.

The three systems for gas separation now before us differ perhaps most strikingly of all in the way in which they produce this refrigeration.

LINDE SYSTEM

In the Linde system, Fig. 4, the gas mixture to be separated is pumped at very high pressure (say 1500 to 3000 lb. per sq. in.) into leg A and simply allowed to expand through a regulating throttle to a lower pressure at B_2 and return through D, the refrigeration being usually credited to the "Joule-Thomson effect." A discussion of this latter here would carry us too far into theoretical physics, but it may help the uninitiated in such matters to intelligently picture the general effect of this process to say that the specific heat of a highly compressed gas is usually

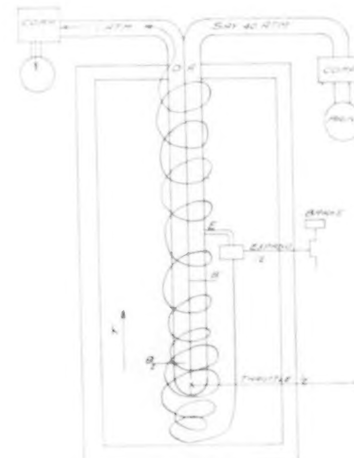


FIG. 5 CLAUDE SYSTEM

less than that of the same gas at lower pressure, so that a given weight of gas passing down leg A under high pressure in falling from one temperature to another will give up fewer calories of heat than the same weight of gas coming up the leg D will absorb between the same two temperatures. Thus it is evident that on the whole more heat will be carried out of the system by the issuing gas than is brought in by the incoming, with resulting refrigeration.

The fact that these differences of specific heat only become important at considerable pressures and the pressure created for this purpose is practically wasted at the throttle, as far as useful mechanical effect is concerned, makes this process decidedly inefficient from a thermodynamic standpoint; i. e., from the question of power consumption. Its chief merit lies in its extreme simplicity and freedom from moving parts. It is the type of system first developed both in the laboratory and commercially. As cooling proceeds, liquid finally forms at B_2. For the purpose of separating the constituents of the mixture the leg D is developed into a "column still" on the same principle as those used for rectification of ordinary liquids, but, to avoid confusion, not shown in the present cuts.

CLAUDE SYSTEM

In the Claude System, schematically represented in Fig. 5, another principle is introduced. It was early pointed out by Lord Kelvin and others that, if some sort of expansion engine could be substituted for the free-expansion throttle in systems of the Linde type, and the work of these engines expended outside the heat-tight room, greater refrigerative effect would be produced even if all the mechanical work so produced were allowed to go to waste, for in its mere production it would have already extracted an equivalent amount of heat from this room. As, for the purposes in hand, these engines must work at very low temperatures, grave mechanical difficulties were seen in the problems of lubrication, brittleness of valves, stoppage by frozen impurities from the gas and the like. George Claude of Paris was the first to solve these difficulties, at least in a commercial way, and his book,[1]

[1] Liquid Air, Oxygen and Nitrogen.

(Continued on page 188)

MACHINE SHOP SESSION

Papers and Discussion on Standardization Subjects at the Annual Meeting, Arranged by Sub-Committee on Machine Shop Practice

THE Sub-Committee on Machine Shop Practice carried through a timely undertaking at the Annual Meeting in its session for the discussion of papers on standardization subjects contributed from authoritative sources, both in England and America. These papers were published in the November and December numbers of THE JOURNAL, and had the following titles, which are descriptive of their contents:

THE BRITISH ENGINEERING STANDARDS ASSOCIATION, C. le Maistre, Secretary of the Association.

WORK OF THE BRITISH ENGINEERING STANDARDS ASSOCIATION ON SCREW THREADS AND LIMIT GAGES, Sir Richard Glazebrook, C. B., F. R. S., Director of the National Physical Laboratory.

PRESENT PRACTICE IN THREAD-GAGE MAKING, Frank O. Wells, Member of Congressional Screw-Thread Commission.

MEASUREMENT OF THREAD GAGES, H. L. Van Keuren, in charge of gage testing, Bureau of Standards, and Secretary of Screw-Thread Commission.

STANDARDS FOR LARGE TAPER SHANKS AND SOCKETS, Luther D. Burlingame, Brown & Sharpe Mfg. Co.

R. E. Flanders, Chairman of the Sub-Committee on Machine Shop Practice, presided, and in opening the meeting said that while the papers had been prepared under conditions incident to the war, the subject of standardization has its peace-time value as well, and particularly in relation to the international aspects of the question. It would be a misfortune for the engineers of France and the engineers of other great industrial countries each to standardize their own practice, their own work and their own product without reference to the practice, work and product of the other great engineering and productive countries. In order, therefore, that we may be kept in a current of standardization with our allies, it has been thought wise to have presented reports from authoritative sources as to the fine standardization work which has been done, particularly in Great Britain.

BRITISH ENGINEERING STANDARDS ASSOCIATION

The first paper, on The British Engineering Standards Association, was presented by Gen. L. R. Kenyon of the British War Mission, who explained the relationship of the association with the British Government. "In my country," he said, "we generally find it best—I have been a government official myself—to get along without the government in most cases. The government is apt to be rather 'red tapy' and slow in its methods, hence this matter of standardization was taken up by a number of engineers connected with the engineering societies in London. They asked the various government departments to coöperate by putting members of these departments on the committees of the association and allowing people to be sent to give evidence before the committees.

"This work began in 1901 under a slightly different name from that which it now has, and to show how modestly it started, it will be seen from Mr. le Maistre's paper that there were only seven men on the original committee, whereas now the association includes 100 different committees and sub-committees, with something like 900 members. They all work under one central authority, composed of boards nominated by the leading technical institutes in Great Britain, such as the Institution of Civil Engineers, Institution of Mechanical Engineers, Institution of Electrical Engineers, the Iron and Steel Institute, the Institute of Naval Architects, etc."

Sir Richard Glazebrook's paper was next presented by H. Bingham Powell, Director of the Joint Gage Laboratories of the British War Mission and of the U. S. Bureau of Aircraft Production. Mr. Powell said in part:

"Although Sir Richard Glazebrook is principally known as the Director of the National Physical Laboratory, he has done much other important work during the war. He has the official position of Consulting Scientist to the British Government, where his wide knowledge of physical science has been of great value.

"Quite early in his career he was demonstrator of physics at the Cavendish Laboratory of Cambridge University. He has written many books and papers for the Royal Society and other scientific and technical societies and journals; and has also been a President of the Institution of Electrical Engineers. He has taken an active part in standardization, especially in relation to screws, and it is of the latter I would now like to speak.

"Sir Richard presided over the Anglo-American Conference on screw threads held in London early in the year. That conference was not able to arrive at final decisions, but useful work was done. In concluding the proceedings, it was agreed that the principal reports of the members of Sub-Committee on Screw Threads of the British Engineering Standards Association should be published in a summarized form in the United States—to present the views held in England on the advantages and objections to the angles, forms, pitches, etc., of the various thread systems in use.

"I was charged by the committee to do this work and have presented the summary, together with some writings of my own on the subject, to the Standards Committee of your Society, and to the National Committee on Screw Threads.

"The ideas held in England may be briefly presented as follows: The British Standard Fine series of threads is becoming very popular for ordinary engineering work. It has long been felt that the British Standard Whitworth Series and the United Standard Series—which are identical except for one size, ½-in. diameter—are too coarse for ordinary work; that is, contain too few threads per inch of length. On the other hand, they claim that the American Society of Automobile Engineers' series is unnecessarily fine for ordinary purposes.

"The British Standard Fine series is almost mathematically a mean in coarseness to these mentioned, and so would seem to meet all common requirements.

"It is most desirable, in many ways, that an international screw system should be adopted; and the feeling in England is that if we can agree in the matter of pitches, the form and angle of the thread can be allowed to take care of themselves; at least for the time being.

"Although the form of the United States Standard thread looks so different on paper from the Whitworth form, in practice there is not much difference. The square top and bottom of the United States Standard are hardly ever found in ordinary commercial screws made by taps and dies, or rolled. The crests of the thread in a tap, or in a cutting or rolling die, very soon become rounded in use by the corners overheating and falling away—thus early arriving at a radius which measurements show approaches the figure of 0.137 multiplied by the lead.

"This is the proportion laid down for the Whitworth rounding. The latter would thus appear to be about the correct rounding with which a tool maintains a stable point.

"Also, the roots of taps and cutting or rolling dies do not give a square form to the product—even if they are made of that shape—but a rounded form, similar in radius to the Whitworth. This is probably due to the fact that in such work the operation of forming the thread on the product is really partly that of extrusion; that being so, the square or sharp V root is not suitable and the metal refuses to flow completely down in it, remaining rounded, as stated.

"Thus we do not differ much over form; but should it be really considered necessary to give a complete solution to the problem, we could fix a 'zone of tolerance of form' at the root and crest of the thread, to include both the nominal square shape and also the rounded.

"About the angle of the thread: The variation of this actually found in the product is so great that the nominal difference of 5 deg. between the U. S. Standard and Whitworth threads is not

of great consequence. We have conducted many experiments in our laboratory—and in England also they have extensively investigated the point—and we find that with the same pitch the average Whitworth bolt will assemble in the U. S. nut, or vice versa; either freely or using a light wrench."

Discussion on Standardization

Henry Harrison Suplee called attention to the importance and value of standardization if rightly carried out. The great desideratum is that standardization shall be applied to details, such as rail sections, bolts, nuts, etc., rather than to the standardization of the whole design. A good example is that of aircraft work, to which General Kenyon referred. Undoubtedly this work has been unnecessarily retarded by many, many small changes, whereas standardization in details would have greatly accelerated production. At the same time standardization in the whole design would have retarded the work and perpetuated obsolete types. In the event of making improvements, the designer would be able to assemble any new design without departing radically from standardized parts. It is desirable that we should consider standardization as it relates to details, which can become almost antiquated without serious detriment, and keep it carefully away from general design where it may retard progress.

Chester B. Lord discussed the difficulties experienced in attempting to use thread gages in manufacturing operations, and said that "nothing has been more costly during the war, or done more to retard work, than the thread gage; not because it is harmful in itself, but because we have so far outstripped in our art of making threads the art and method of making gages." He emphasized the effect of drawing a thread when a bolt is stressed, by which mating threads of different shapes conform to one another, in consequence of which it is the lead rather than the shape of thread which counts. Consideration of the material on which a thread is to be cut is of the greatest importance in making a thread gage—whether open-hearth or bessemer steel, brass, copper or cast iron. He had manufactured with Whitworth, U. S. Standard and V threads as a basis on different work, and hoped later to be able to contribute a discussion in writing covering his views.

James Hartness emphasized the importance of the accomplishments of the two great institutions, the National Physical Laboratories of the British Government and the Bureau of Standards in this country. The latter came into the work a little later, and under less pressure, but has been making remarkable headway, and both are built around men who have the highest ideals and are endowed with the clearest perception with regard to gaging standards.

Commenting on the remarks by Mr. Lord, he said that while the purpose of gaging is to determine the character of the fit, we must measure the screw thread before it enters under the stress of its work. The gage, therefore, does not indicate what the fit will be when the screw is under stress. He hoped later to present a communication to the Society on this phase of the subject, and for the present would merely say that the work of the projection lantern as it has been first worked out under the auspices of the National Physical Laboratory, and as it is being carried forward by the Bureau of Standards, promises to bring us one step forward in the art of making screw threads.[1]

E. J. Bryant[2] said that in this thread-and-gage proposition we should remember that the purpose of a screw thread is to bind parts together. As a manufacturer of threads, gages and other parts, the thing which seemed to him to be vital to consider was what the standard of variation should be from the pitch or effective diameter of the thread. Knowing that, we would be able to make gages that would check the parts, and to make parts to these gages which would interchange with the parts made by other manufacturers.

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[1] Mr. Hartness' communication appears in this number of Mechanical Engineering, pp. 127-135.

[2] Supt. Small Tools Division, Taft-Pierce Mfg. Co., Woonsocket, R. I.

The Engineering Standards Committee

Comfort A. Adams spoke of standardization as a basic matter of the greatest importance, and of the work of standardization contemplated by the recently organized American Engineering Standards Committee. [See Mechanical Engineering, January 1919, p. 70.—Editor.]

If a thread has been standardized, all that is necessary to designate it is to say that it is a standard thread of a certain diameter. That describes the whole thread. It is known the nation over. If it is an international standard, it is known the world over.

Another illustration is the rating of electrical machinery. It took some time to develop a satisfactory system of rating by which it would be known exactly what was meant where one said that a motor of a certain voltage, for example, had a certain horsepower. It might take many pages to describe the motor, to tell how to test it and how to check the rating; but today, in view of standardized ratings, the designating term for a motor signifies a certain definite thing which is understood not only throughout this country, but in England as well.

Standardization produces a language of marked abbreviation and results in a saving of time and misunderstandings which has been of tremendous benefit and of immeasurable importance to the engineering world.

The extent of the saving through the adoption of standards in the electrical industry is incalculable. As the world of industry develops and our relations with other nations become more and more intimate, it becomes more and more necessary that we talk the same language. Every difference in language of any kind or description creates a barrier between nations and helps to produce the misunderstandings which cause war.

With regard to the American Engineering Standards Committee, while its organization is different from that of the British Engineering Standards Association, it is hoped that it will be effective and will result in a large saving of time and bring about a better understanding in our international relations.

The operation of the Committee can best be explained by stating the order of procedure in the development of standards under the guidance of that Committee.

A standard is proposed and accepted as desirable by the Committee. It is then referred to the sponsor society, which appoints a Sectional Committee representative of that society and of other interested organizations, roughly in the proportion of their interest. The personnel of that committee is referred for approval to the American Engineering Standards Committee, and if the constitution and personnel of the Sectional Committee satisfy the main committee and its regulations in that respect, the personnel is approved, and the committee goes to work and evolves the standard, which becomes at first the standard of the sponsor society, and is published by it. Then if approved by the main committee of the American Engineering Standards Committee, the sponsor society is granted the right to have printed on the pamphlet of issue the statement—"Approved by the American Engineering Standards Committee." Thereby that standard becomes an American standard. We have been in the closest touch with the British committee, and with Mr. le Maistre, and in the future we hope that the international conferences will include the American Engineering Standards Committee.

Pioneer Mechanic Introduced

Frank O. Hoagland, representing the Pratt and Whitney Company, whose pioneer work in gages and standards is known and recognized the world over, very appropriately and courteously referred to one of the company's old employees, saying: "Many times it is of interest to see what has been done before. One of the principal difficulties is that the men who have accomplished the most do not always care to tell about it, either orally or in writing. There is a gentleman in this hall by the name of G. S. Fallow, chief gage inspector for our company, who has been with the company for more than forty years. He was there in the days when Mr. Bond and Professor Rogers tried to establish a new art.

"These gentlemen did a lot of experimental work in this coun-

try first, and then they took their measuring bar to England and had it compared with the master bar over there. There gages were being produced then because the railroads were beginning to call for nuts and cap screws that would interchange. In those days Mr. Fallow was working at the bench and lathe, and produced thread gages which stand comparison today with the latest instruments. Some of the gages were ground in 1883. It is remarkable how close they are, considering the means at hand at that time."

Considerations in the Standardization of Screw Threads

Wm. T. Magruder (written). If another set of standard sizes of screw threads is to be added to the variety now in use in engineering construction, it is to be hoped that it will be done very advisedly and with full consideration of the materials that will be employed and the uses that will be made of the threaded members. It can probably be shown that there are more miles of bolt threads cut per annum from ordinary steel bolt stock than from any other one material or for any other one use. While special threads may be desirable for automobile tool-steel threaded members and for the bronze screws of astronomical and physical instruments, the thread upon which civilization rests and progress depends is the screw thread used in bolts and screws in general engineering machinery. It is therefore of the greatest importance that standards of materials, shapes, sizes, limits, and the like should be decided on with great care and that no radical changes be made in present practice except after very serious consideration of the millions of dollars of expense and endless confusion involved in any such change. Experience gained in changing from one standardized thread to another, and later to another in engineering manufacturing work, leads me to speak positively on the subject.

Any committee having this matter in charge should decide on what may be considered to be standard engineering materials, and should then experiment upon the relative strengths and fatigues of the threads made of these materials in machines simulating actual use. By strength is not meant solely the tensile strength of the threaded member, but rather the strengths in tension, torsion and shear. One of the experiments which we have our engineering students perform at Ohio State University is to test ordinary commercial steel machine bolts by screwing the nut up with a wrench and to see that they usually fail by stripping the threads. This would indicate that the pitch was too fine or the fit too loose.

Seventeen years ago we found it impossible to get bolts and screws cut with U. S. Standard threads from any of the manufacturers located west of the Allegheny Mountains, and had to send to Worcester, Mass., to get the desired supply of standard bolts, cap screws and studs. While such is no longer the case, it would be interesting to learn how common the old, sharp-V, American thread still is and what proportion of screw-threaded members made in the Middle West are now made to a more or less approximate sharp V thread rather than to the U. S. Standard thread.

For the last four years screw-threaded members as used on munitions have been forced to the forefront of our attention. Now that we are again to allow the manufactures of peace to lead the way, more thought should be given to the commercial needs of this branch of engineering practice. The accuracy demanded and obtained in Government work does not always obtain in commercial work.

While full credit should be given to Sir Joseph Whitworth as being the first one to bring order out of screw-thread chaos and to successfully standardize British screw threads, it should be borne in mind that the Whitworth screw thread is very difficult to duplicate, an expensive thread to make as far as accurate taps and dies are concerned, and still more difficult and expensive to cut with accuracy in the lathe. It therefore seems the part of wisdom, now that the International, French and United States screw threads are all of the 60-deg. Sellers type of thread, to retain it as a standard shape—at least until something better can be devised.

E. H. Ehrman (written). Obviously the two main points of difference between the British and American screw threads for constructional bolts rest in (1) the pitches of the finer series and (2) the contour of the crests and roots.

With reference to the first point, the difference is in all probability the result of looking at the matter from different viewpoints. The British feel that one series of pitches serves satisfactorily for all grades of work, whereas in the United States we feel that requirements are better met through a dual system of pitches. Had the British held our view, or conversely, had we held the British view, the few differences that might occur in the resulting British and American series could easily have been adjusted through conference.

With reference to the second point and with special reference to the second paragraph of p. 1008 and the last paragraph of the first column of p. 1009, The Journal, November 1918, I would offer the following comment: The time has come, I believe, when we must, in a specification, do more than prescribe the profile that forms the ideal boundary between the external and internal thread. We should, I believe, specify the maximum tool profile, i.e., that profile of the tool which when new will produce a screw with the deepest root and the highest crest; as well as profiles of the "go" gages, which should be so shaped that the product gaged by them will not trespass upon the standard profile. Provision is thus made for a definite maximum clearance at the crest and root, and also for wear of the crest of the tool.

My experience with reference to the action of the thread tool at its root does not agree entirely with that of the author. Outlines of screw threads, both external and internal, on an enlarged scale of 50:1 indicate that the thread tool at its root suffers very little if any wear in service, as the crests of the thread are fairly true to the theoretical profile where it has been entirely formed by the thread tool. Where the bore of the nut has been enlarged and the outside diameter of the screw has been reduced so that the threading tool removes nothing from the crest of the resulting thread, the metal at the edges of the crest, instead of being removed, is built up or spun up, so that they are slightly higher than the surface at the middle of the crest. Observation also shows that the thread tool has under such conditions cut the thread fairly concentric with the bore of the nut and the body of the screw.

With the provisions made for clearance as cited above, I believe (1) that considerable eccentricity of the thread with reference to the bore or body diameter is permissible and (2) that much latitude may be allowed with reference to the shape of the tool crest. In fact, it is immaterial except as to the relative "life" of the thread tool, whether the crests of the tool be of the Sellers or Whitworth shape. My personal experience, however, is the ground for my preference for a thread having flattened crests and roots. The reasons for this opinion are given in a paper on the Screw Thread Situation in Great Britain and America which I read before the Society of Automotive Engineers.

Thread-Gage Making and Testing

The next papers presented were by Frank O. Wells on Present Practice in Thread-Gage Making and by H. L. Van Keuren on the Measurement of Thread Gages. These papers are both comprehensive and practical, representing as they do the most advanced practice. Considerable discussion followed.

As a preface to his paper, Mr. Van Keuren said: "Some time ago the Gage Committee of the The American Society of Mechanical Engineers recommended that there be a central place for the certification of master gages, and that as Congress had provided a fund for this purpose for the Bureau of Standards, and as the Bureau of Standards was organized and ready to handle the work, it should be the central place for the carrying on of this work. It is of interest, therefore, that members of the Society should know some of the developments which have taken place there."

H. J. Bingham Powell[1] (written). The number of gages inspected during the last few months by the U. S. Bureau of Air-

[1] Officer in Charge of the Joint Gage Laboratories of the U. S. Bureau of Aircraft Production and of the British War Mission.

craft Production and of the British War Mission is from 15,000 to 18,000 a month, and a program of a thousand gages a day was under consideration when the war terminated. Over 80 per cent of the gages were screw gages, with the low tolerances of two ten-thousandths of an inch on the pitch diameter and the same figure for the maximum lead error. The other gages were the complex form, flat and angle gages used in aircraft engines and aeroplane inspection generally. We employ girls for the work as far as possible, men only being needed for the more complex gages and where experience in gage making was necessary, such as in the visual inspection, etc. The girls have given most admirable service and have been found to be fully qualified by their patience, steady work and light touch for dealing with the very delicate instruments we use. Our instruments have been especially designed, bearing in mind the unskilled workers who had to use them, and are practically "automatic" in action.

For instance, our lead-measuring machine shows the correct reading to within two one-hundred thousandths of an inch by the swing of a galvanometer needle. Ten machines deal with 500 gages a day, with errors in readings almost unknown. The National Physical Laboratory pitch-diameter machine described by Mr. Van Keuren has been modified by us by fixing an attachment to it which puts a constant load on the wires and does away with the feel of the micrometer, a small lamp extinguishing when the reading is correct. The results given by the different pitch-diameter machines are thus obtained under identical conditions of loading of the wires and pressure on the micrometer spindle: the latter having on its barrel a divided wheel by which readings can be taken to a fraction of a ten-thousandth of an inch.

The horizontal type of the National Physical Laboratory optical projection lantern is used with a lens that gives a correct field 8 ft. in diameter. We photograph all the plug gages and the casts of ring gages by means of a special apparatus which takes less than one minute to operate. The photographs are measured for angle of thread and checked for form by placing them over suitably engraved glass screens illuminated from underneath.

To take casts of ring gages we have a special appliance that does the work in a few seconds. All this apparatus has been designed for dealing with our large number of gages with expediency and accuracy without having to employ highly skilled mechanics who in war time can be better employed elsewhere.

Data from Frankford Arsenal

C. P. Colburn[1] (written). The object of this discussion is to show how methods of precise measurement may be simplified and adapted to practical use.

Measurement of Pitch Diameter of 60-deg. Thread by 3-Wire System

The usual trigonometric formulæ for determining the correct wire size and the over wire dimension for determining pitch diameter of thread gages and taps is a problem too deep in mathematics for many shop mechanics. The formulæ here given are intended for the workman who is not a mathematician, but who finds it necessary to make calculations due to the fact that drawings are not generally arranged to show over wire measurements and the correct size of wire which should be used to obtain the best results.

The following formulæ will render equally correct results and may be used for all styles of 60-deg. threads by any one who has a knowledge of ordinary arithmetic. In both instances the size of wire used should be such that the points of tangency will lie in the pitch line.

Diameter of Wire.. (See Fig. 1.) The diameter of wire which will touch the sides of the thread at the pitch line = ⅔ depth of a sharp V thread. The depth is determined by dividing ½ the decimal pitch by the tangent of ½ the included angle, or by 0.57735.

[1] Major, Ord. Dept., U. S. A.; Gage Dept., Frankford Arsenal.

$$W = \frac{2}{3} D \qquad D = \frac{H}{\tan 30^\circ}$$

$$W = \frac{P \text{ (Decimal)}}{1.7321}$$

where

P = pitch

W = diam. of wire

H = ½ pitch

D = depth of sharp V

Pitch Diameter. The pitch diameter of a thread gage or a tap

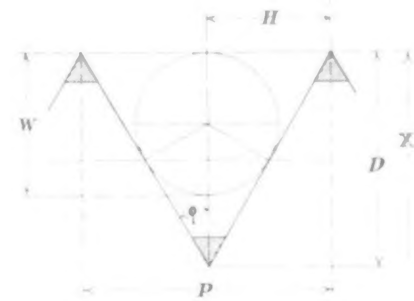


Fig. 1 Diameter of Wire to Touch Threads at Pitch Line

can be computed by substituting the measurement over the wires and the mean diameter of wire in the formula

$$PD = X - 1.5W$$

where

PD = pitch diam.

X = measurement over wires

W = mean diam. of wires.

The dimension over the wires is found by adding 1.5 times the mean diameter of the wires to the pitch diameter as given in Fig. 1. Any variations from the measurements thus found indicate over or under size at pitch diameter.

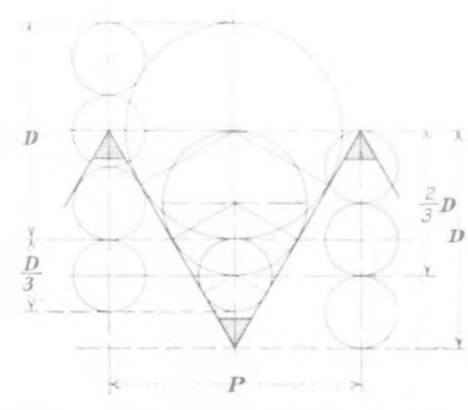


Fig. 2 Checking Angle on 60-deg. Threads with Standard Best Wires

Test for Angle of 60-Deg. Thread by Use of Wires

The angle of a 60-deg. thread can be tested by using two wires, the diameter of the larger being equal to the single depth of a sharp V thread and the smaller equal to ⅓ the single depth of the sharp thread. (See Fig. 2.) Knowing the diameter of the wire, which is tangent to the sides of the thread at the pitch line, the diameter of the large wire can be found by multiplying that value by 3 and dividing by 2. The diameter of the small wire is equal to ⅓ the diameter of the large wire.

When both wires are placed in the thread and touching the sides of the thread, they will be tangent to each other at the pitch line.

To make this system practical for the checking of angles, the

small wire ($D/3$) should be made in two sizes and used as a "go" and "no go" gage. The sizes of "go" and "no go" wires are determined by the allowable tolerance of the angle. The large wire being held against the angle of the thread will permit the small "go" wire to pass underneath. The "no go" wire should not pass, if the angle is within the specified tolerance.

The larger wire touches slightly below the top of the U. S. Standard thread approximately a distance equaling the flat on the top of thread. The small wire lies on the angle at the same distance from the root of the thread. This makes the approximate range of the angle test about $\frac{3}{4}$ the depth of the thread.

The writer recommends that working drawings show methods of inspection and all necessary dimensions. This will obviate many errors, usually resulting in the complete loss of the article. This method also reduces the cost of computation, which would be made once, whereas in the present practice the shop mechanic and inspector usually work separately, thus naturally increasing the cost of the product.

Luther D. Burlingame referred to the joint meeting of the Society with the Institution of Mechanical Engineers in England in 1910, when Sir Richard Glazebrook was kind enough to say that, while Great Britain had shown the way toward standardization and toward interchangeability of parts, it had been the part of America to put that into practice. Now the table is turned, and as we read of what has been accomplished at the Bureau of Standards, we find that we have ourselves been learning the advanced work which had been done in Great Britain so that the two great Anglo-Saxon peoples are working together, each to help the other in carrying these matters toward solution. We must remember, however, that the final question is not that of gages, but of knowing that the final product will be workable and satisfactory.

He said that Mr. Wells has expressed the thought that there are so many steps in the question of tolerances, that a much more complicated problem is presented than would seem on the face of it. As an aid to this, however, we have the possibility of combining the errors of lead and diameter in such a way that an increased error of diameter may be compensated for by an error in lead, and as far as we can take advantage of this condition we can increase our tolerances; but the last word will not be said in this matter until we have means of combining measurements so that we know what is the combined error of diameter and lead.

H. H. Suplee, in alluding to the praise Mr. Hartness had bestowed upon the work of the National Physical Laboratory and the Bureau of Standards, reminded his hearers that the latter was established as a result of a paper presented before this Society some 25 years ago by James W. See, of Hamilton, Ohio. Mr. See wrote a paper on standards, and after he had presented it, he recommended that there should be a Bureau of Standards established by this Government. A committee of this Society went to Washington and the Bureau of Standards was established. The National Physical Laboratory was started after that, but the whole idea of the Bureau of Standards originated in this Society.

Standard Tapers for Shanks and Sockets

The final paper by Luther D. Burlingame on Standards for Large Taper Shanks and Sockets, was briefly discussed.

Wilfred Lewis wrote in approval of the $\frac{3}{4}$ in. per foot taper for large taper shanks and sockets, but was not so sure about the lengths recommended—he did not see why all shanks and sockets should not be similar in every respect. He was disposed to agree with Mr. Walters of the Westinghouse Company in advising a length of three times the diameter.

He thought Mr. Burlingame had done well in his choice of sizes: 4, 5, 6, 7, and their multiples by two, making 8, 10, 12, 14; thus forming the basis for a rational progression in sizes, stepping up again to 16, 20, 24, 28, or down by division to 2, 2.5, 3, 3.5 and so on, as far as may be desired. He did not believe, however, in designating these by the numbers 19, 20, 21, etc., as proposed. No. 19, also, conflicts with No. 19 of the Jarno taper. He would prefer to designate the tapers by the sizes themselves.

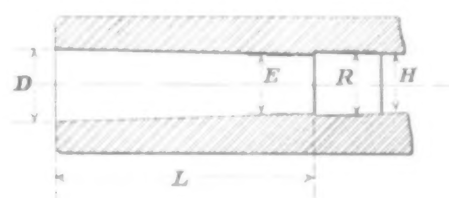
"There was a movement years ago," he wrote, "to abolish all numbered sizes for any purpose whatever, and I think it should be revived. The late James Christie was active in the promulgation of this idea, which I found quite easy to follow, because the actual size was always the thing desired, while the arbitrary number given to it was a matter of no interest whatever.

"I suggest, therefore, as an amendment to the system proposed that the number of the taper be omitted, and that the length of taper be made three times the diameter at large end, instead of twice plus four."

William Bacon. (Written.) During the past three years the Reed-Prentice Company has made a study of the subject of lathe centers and has adopted for its use a formula based on the Jarno taper.

The taper adopted is 0.6 in. per ft.; length = 2 × diameter of large end + $1\frac{3}{4}$ in., and the number of taper is designated by diameter × 8. The following table gives the dimensions for the lathes made by this company.

Dimensions of Lathe-Spindle Tapers



(All dimensions in inches. No. of taper = $D \times 8$; $L = 2D + 1.75$ in., $E = D - 0.05L$; $R = E + \frac{1}{32}$ in.)

No.	Lathe Size, Inches		D	E	L	R	H
	Reed	Prentice					
9	12 engine (existing)	. . . . .	$1\frac{1}{8}$	0.925	4	$E + \frac{1}{32}$	$\frac{15}{16}$
11	12 engine (new design)	12 H. S.	$1\frac{3}{8}$	1.150	$4\frac{1}{2}$	$E + \frac{1}{32}$	$1\frac{1}{8}$
12	14 engine	14 H. S.	$1\frac{1}{2}$	1.263	$4\frac{3}{4}$	$E + \frac{1}{32}$	$1\frac{1}{4}$
13	16 engine	16 H. S.	$1\frac{5}{8}$	1.375	5	$E + \frac{1}{32}$	$1\frac{3}{8}$
15	18 engine	18 H. S.	$1\frac{7}{8}$	1.600	$5\frac{1}{2}$	$E + \frac{1}{32}$	$1\frac{1}{2}$
17	20 engine	20 H. S.	$2\frac{1}{8}$	1.825	6	$E + \frac{1}{32}$	$1\frac{3}{4}$
17	22 engine		$2\frac{1}{8}$	1.825	6	$E + \frac{1}{32}$	$1\frac{3}{4}$
19	24 engine	24 H. S.	$2\frac{3}{8}$	2.050	$6\frac{1}{2}$	$E + \frac{1}{32}$	2
23	27 engine	27 H. S.	$2\frac{7}{8}$	2.500	$7\frac{1}{2}$	$E + \frac{1}{32}$	$2\frac{1}{2}$
23	32 engine	. . . . .	$2\frac{7}{8}$	2.500	$7\frac{1}{2}$	$E + \frac{1}{32}$	$2\frac{1}{2}$
9		No. 00 Auto.	$1\frac{1}{8}$	0.925	4	$E + \frac{1}{32}$	$\frac{15}{16}$
11		No. 0 Auto.	$1\frac{3}{8}$	1.150	$4\frac{1}{2}$	$E + \frac{1}{32}$	$1\frac{1}{8}$
14		No. 1 Auto.	$1\frac{3}{4}$	1.487	$5\frac{1}{4}$	$E + \frac{1}{32}$	$1\frac{1}{8}$
14		No. 2 Auto.	$1\frac{3}{4}$	1.487	$5\frac{1}{4}$	$E + \frac{1}{32}$	$1\frac{1}{8}$
18		No. 3 Auto.	$2\frac{1}{4}$	1.937	$6\frac{1}{4}$	$E + \frac{1}{32}$	$1\frac{1}{8}$
11	14 X. H.	. . . . .	$1\frac{3}{8}$	1.150	$4\frac{1}{2}$	$E + \frac{1}{32}$	$1\frac{1}{8}$

The timely address by Dr. Frederick G. Cottrell, Chief Metallurgist of the Bureau of Mines, on The Liquefaction and Separation of Gases, an abstract of which appears elsewhere in this number, records one of the most important industrial developments of the past year, i. e., the low-cost production of helium for use in dirigible and observation balloons. During the period of the war, so Doctor Cottrell relates, the word "argon" was used in all correspondence as a code term for helium. While argon and helium are both inert gases, argon is too heavy for use in balloons, and is familiar because of its extensive use in the incandescent-lamp industry. It was thought, therefore, that the term would be a particularly effective camouflage, which actually proved to be the case, since there is evidence of the two words being confused in the public's mind. Doctor Cottrell urges, now that all secrecy has been abandoned, that the correct term, helium, be used whenever referring to the subject.

CORRESPONDENCE

Contributions to the Correspondence Departments of Mechanical Engineering by members of The American Society of Mechanical Engineers are solicited by the Publication Committee. Contributions particularly welcomed are suggestions on Society Affairs, discussions of papers published in The Journal, or brief articles of current interest to mechanical engineers.

"Over the Top" in France

To the Editor:

I am in receipt of your letter of the 31st ult., and will say that on my return to the States I may be able to contribute some articles from my experiences and observations over here that will be of interest for The Journal and I will try to arrange this. I am first and last for anything that will be of interest and aid to anyone in any of the engineering lines.

My regiment spent the last three months of hostilities in front-line work without a day's rest, and on two or three occasions was on duty three days and nights without rest or sleep—then a four hours' rest and back into the big game—not a murmur nor a complaint. That is a good sample of our boys as I have seen them. They have done wonders which in many other countries would call for lavish praise and commendation, but which with us was merely a part of the day's work. As one of the Corps Engineer Officers, 1st Army Corps, First Army, I saw nine different divisions go in and out, and in action in one of the most heavily fortified or organized sections of the front. Their deeds of heroism were legion and probably few of them will be chronicled; but I have seen them chronicled on the terrain of France, whether it was down the slopes of Hills 304 and 295 and over the summit of Monfaucon, or in the Bois de Cheppy—names that have stood forth in letters of fire and blood since February, 1916, when the German ambitious attempt to take Verdun started. From the Swiss border to the North Sea you will find at intervals little plots filled with crosses bearing metal disks with such names as Ferrati, Grunsky, Jones, Murphy and Schuster—damned good Americans, all of them.

When I landed in France in June things were gloomy. The German offensive was still on and going good. The Allies were standing sledge-hammer blows and had been for four years. They had seen month after month and year after year of deadly fighting and were tired. It seemed as if they must be forced to acknowledge defeat before the United States could bring her resources to bear. They knew we were sending men, and thought that they would help some by putting a regiment here and there, but they did not believe that such a thing as an American Army could be possible for another year.

The "Pershing System" had been under way for about a year when I landed in France in June, and while this "system" had not been trumpeted about, there was one man at least who knew what was being done, and that was the American Commander-in-Chief. In the dark days when the Germans swept forward to the Marne for the second time, General Pershing placed all the resources of the American Army at the disposal of Marshal Foch. No doubt our allies expected a division here and there sandwiched in between veteran troops to help some, but if the truth were acknowledged that is about all they expected. Then came Chateau-Thierry and Belleau Wood, and our allies stirred. By chance, when the Germans crossed the Marne with Paris as an objective, two of our divisions were directly between them and their objective. The Germans began their "infiltration" methods that had been netting them gains everywhere, but our divisions opened at 800 yards with a deadly, aimed rifle fire that wrecked the German system. Aimed, accurate rifle fire in the heat of battle amazed our allies.

When the accurate rifle fire had shattered attack after attack, our divisions went forward with the bayonet with an enthusiasm and an earnestness that surprised the French and disheartened the Germans. Then followed the advance from the Marne to the Vesle, and our men occupied the hottest part of the line and held their own with the French veterans. Some divisions of the famous Prussian Guards were sent in to stop the "schweinhund" Americans at all costs, but they were cut to pieces just as badly as if they had been only Landwehr divisions. It may have been that our boys had been too busy practicing the art of war to study up on the Prussian Guards and didn't know they were "famous," but my impression is they simply didn't give a rap—they were simply Boche, and being Boche were due to get cut up.

The fighting on the Marne and to the Vesle was not only a great victory, but it was more than that. Our allies were introduced to the American divisions as fighting units that could hold up their end under any conditions. The "pep" and the unbounded enthusiasm of the American soldier became infectious. A little of the tired and gloomy looks began to disappear. General Pershing had built his system around his conception of the American man as a soldier, and American manhood did not fail him.

In August the organization of the First American Army was announced. General Pershing assembled his veteran divisions and some that were comparatively new. On September 12 the world learned that the First American Army had made an independent move—a stroke against the famous St. Mihiel salient that had been a thorn in the side of France for four years. In less than a week this entire salient was wiped out and 15,000 Germans captured, together with hundreds of guns and enormous stores. Thus the First American Army made its bow to the world. While the St. Mihiel operations were conducted by the First Army, yet it was not all there by any means, but it was assembling and taking over the lines in the Argonne-Meuse sector and the heights north of Verdun, and on September 26 the First Army went "over the top" on a forty-mile front in the greatest military offensive the world has ever seen.

The pinching out of the St. Mihiel salient was only a prelude, a curtain raiser, for the "main act" that was only to end when Germany surrendered unconditionally. The sides of the St. Mihiel salient were backed by natural positions that were strong in themselves and sections of the German line from St. Mihiel to Pont-à-Mousson were lined with a network of concrete machine-gun positions ("pill boxes"), so the whole salient was a sort of fortress that had resisted all attempt at capture for four years. As for the line held by the First American Army from west of the Argonne Forest to the north of Verdun, this front was as highly organized and protected by every sort of means the Germans could devise. During the four-and-a-half years of the war this section of the line had become almost a vast graveyard—of German hopes as well as of men. Military authorities have estimated that the eight months' effort of the Germans to take Verdun in 1916 cost them 400,000 to 500,000 in killed alone, and the French half as many. Viewing the country from the heights of Monfaucon to the south to Hill 295 (Le Mort Homme) and Hill 304, the only expression I could frame to describe it was a "scene of abominable desolation" as expressed in the Bible—it was pathetic—it was awful.

Recently, since our Army has gone forward to German soil, I stood on the summit of Monfaucon and looked over the country toward Verdun where shells by the million had poured and where men by the hundreds of thousands had died—died for what? only to satisfy the insane desires of a world-power Kaiser to perpetuate a rotten dynasty. This day, in the expanse of country as far as I could see there was not a single living person or thing. The ground for miles was upheaved and torn as by a gigantic earthquake. The ruins of the destroyed towns were dead. It seemed too unreal to be true—just a dead world in which all living beings had returned to dust. There is a pathetic grandeur about these "dead" towns that have been so ruthlessly destroyed. They seem

Members who were in attendance at the Spring Meeting at Worcester will remember with pleasure the address given at that time by Lieut.-Colonel J. Edward Cassidy, U. S. A., on Conditions and Requirements of Warfare, which so electrified the audience and enthused them with regard to the accomplishments of the engineer in the war. Lieut.-Colonel Cassidy was then stationed at Camp Devens, but shortly after went abroad with the Expeditionary Forces.

to say that they have given their all for France and plead that their naked ruins be hidden from the sight of man.

But not all destroyed towns are "dead"—some proclaim their immortality and defy the human agency to destroy them. The town of Montfaucon stands on a hill some 40 meters higher than any of the surrounding country, and the ruins of the town stand forth against the skyline for a great many miles around, and seem to me to be a deathless monument that proclaims its martyrdom but still holds a taunt and a dare to the German to do his worst. Verdun, I call "The City that Could not Die." A city that was so much of a temptation to the Boche as to cause him to waste his soldiers by the hundreds of thousands, and a city that caused the French poilu to perform superhuman deeds in its defense, cannot be an ordinary city. It was a tantalizinz will-of-the-wisp, a sort of end of the rainbow, always just a little distance ahead but always out of reach—to the Germans; and to the French, something too sacred to be permitted to fall into the bloody hands of the invader. Shelled continually day after day and year after year for more than four years, until the grip of the Germans on the approaches to the city was broken forever by the First American Army, "The City that Could not Die," though torn by shells and partly wrecked, stands today and will stand for generations to come as a monument to the valor of the soldiers who defended it so well.

I trust that some writer or historian who can paint word pictures of these ravished towns and cities of France and Belgium will study them while they are yet unchanged, so as to record their history for generations yet unborn.

J. Edward Cassidy,
Lieut.-Colonel, Engineers, U. S. A.

With American Expeditionary Forces
December 1, 1918

Committee on Aims and Organization

To the Editor:

During the discussion of the report of the recently appointed Committee on Aims and Organization at the Annual Meeting, Mr. Spencer Miller—a member of the Council—urged that as a supplement to all that has been said and written on a re-aimed and reorganized A.S.M.E., there should be presented a terse statement of definite steps to be taken in effecting the desired result. "Let them give us 'fourteen' points," was his appeal, as I recall it.

Each member of the Society would probably have his own reply to such a request. No such expression of opinion should be without value in our further discussion. May I submit one group of definite suggestions, each of which appears to me to be both possible and important and some almost vital to our future progress.

Any statement of aims and purposes either for an individual or a society should be elevated in tone and broad in scope. The times invite a position of influence and a breadth of usefulness for the engineer—and especially the mechanical engineer—nowhere suggested in our official pronouncements. Hence fundamental to all genuine progress we should have:

1 *A Restatement of Our Aims and Objects.* Our present activities both in quality and scope transcend the limitations of the Constitution. It would be better if this condition could be reversed. Our Constitution should present a goal to which we could aspire rather than set limits which we have long since passed.

A growing measure of democracy must be developed in all our affairs as for instance through:

2 *Publicity.* Provide at every annual and semi-annual meeting a session at which the affairs of our Society can be discussed with reasonable informality and until everybody is reasonably satisfied; encourage the publication of several pages of such letters as this—not about technical matters but about the life of the Society—in each issue of Mechanical Engineering.

3 *Encouragement of Younger Members.* Grant junior members the right to vote and hold office. The 21-to-30-year-old men vote in city, state and nation. Young doctors vote in the American Medical Association. Why not take a chance on the young engineers? We need both their enthusiasm and their point of view. This class of members will always be in a hopeless minority.

4 *Home Rule.* Remove every possible restraint on freedom of action on the part of local branches.

5 *Popular Election of Officers.* Now that the Nominating Committee is to be elected, put some thought and energy into getting everybody into the play. No mere change in machinery will do it. The proposed system may easily give results less beneficial to the Society than the one it supersedes. Publish a 100-word sketch about each candidate for office. Let the members know for whom they are voting.

6 *Appeals.* Provide for a review of all administrative acts, such as those of the Meetings Committee in rejecting papers and of the Membership Committee in rejecting members. This machinery will not often be used, but its existence will provide a safeguard and remove one of the causes of bitter dissatisfaction in the past.

The prestige of the engineering profession will be enhanced not only as we render increased service but also as we raise our standards of professional conduct, hence we must provide:

7 *A New Code of Ethics.* At one of the sessions of the Worcester meeting a vote in favor of a more advanced code was passed.

8 *Means of Enforcing Standards of Professional Practice.* Such administrative methods are already in force with the American Institute of Architects and work satisfactorily.

Everybody admits that this is the "day of the engineer," and yet as a profession we get almost no recognition because we are cut up into organizations representing divisions and subdivisions of the engineering profession. We should come out frankly in favor of:

9 *One National Engineering Society.* Work for it in season and out of season, and above all until it is accomplished we should do nothing for our own advancement which will make its attainment more difficult.

Certain of our activities require to be taken more seriously—as for instance—

10 *Employment.* In view of some of the work on the classification of the personnel in the Army and the "hiring and firing" methods used by forward-thinking industrial concerns, the employment work of our great engineering societies has been crude indeed.

11 *Public Engineering.* The education on engineering matters which our profession affords the public through its national and its local societies is almost *nil*, as compared for instance with that rendered by the medical and even the architectural profession. Special emphasis should be placed on assistance to be rendered to public officials having engineering for their field.

12 *Engineering Internationalism.* Engineers—and our Society especially—have done much to promote friendly international relations. But the issue of the war has emphasized the importance of such work and we should lay our plans for the future along the broadest lines.

An adequate administrative machine is required for any enterprise. A single executive leader is an essential cog in any such machine. Responsibility implies authority and real authority is not conferred through a title. We need in the A.S.M.E.:

13 *A Salaried Administrator with Power.* Call him Secretary, Executive Secretary, Managing Director or what you like. He must be the working head of the Society elected by the Council and holding office while he gets results. His authority or responsibility should correspond to that of the president of a corporation.

14 *"Chairman of the Board."* This is the function which the President of the Society, elected annually, should be given. We have never had a president who gave enough time to the work of the Society to warrant his assuming the executive and administrative leadership of its affairs. The one-year term would make success impossible.

Our Society has had a splendid part in the development of the art and science of engineering. The times demand both broad vision and indomitable purpose in the application of engineering knowledge to the needs of mankind. Given both, our association of 10,000 members may play a master rôle in the years just ahead.

Morris Llewellyn Cooke.

Philadelphia, Pa.

A Useful Industrial Diagram

To the Editor:

Many methods of showing in diagrammatic form the time-output and similar data are in general use.

The most general arrangement is that shown by Fig. 1, which illustrates monthly fluctuations in output. The output may be

in tons of castings, numbers of automobiles, or may be profit realized monthly, or anything else related to time.

As a record of the past a diagram such as this leaves nothing to be desired.

The executive, however, whether he deal with materials or dollars, is not satisfied with a mere record of what has occurred in the past, but he wants to use the past experience as a basis for consideration or production of the future. It is possible to extend the recording curve of Fig. 1 to indicate a future probability, but this is neither safe nor simple.

Plotting the same data in somewhat different form as in Fig. 2

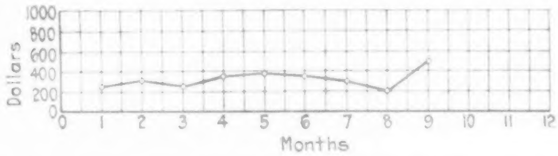


FIG. 1 DIAGRAM SHOWING MONTHLY FLUCTUATIONS IN OUTPUT

answers every question as to the past and also readily predicts the probabilities of the future.

To deal with something concrete, let us say that it is the profits of the business that are being examined, that these are being ascertained monthly, that the corresponding result for the year is desired and that the prediction is to be brought up to date or corrected each month.

In Fig. 2 each month's earnings are plotted to a curve duplicating the usual one illustrated in Fig. 1. This is the lower curve shown.

Over each month there is plotted the total profit to date. For instance, January shows \$250, February, \$300, and the total there-

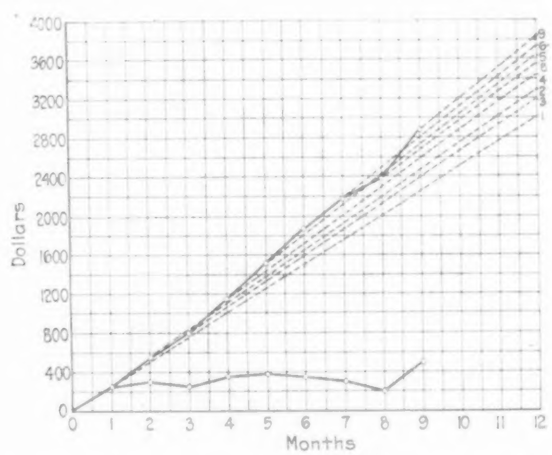


FIG. 2 DIAGRAM FOR PREDICTING YEARLY EARNINGS FROM EARNINGS FOR PART OF YEAR

fore to date is \$550. These are shown by the upper solid curve.

To predict the probable profit for the year it is only necessary to draw a line from zero through the total earnings to date and to continue that line to the twelfth month; for example, the total profit by the end of the fourth month was \$1150; the projection shows \$3450 as the probable rate of profit for the year resulting from the first four months. An examination of the diagram shows that there is an improvement in the second and third months over the first month and an improvement in rate by the end of the fourth month over the previous months. By the eighth month, however, the rate had fallen off from that of the fifth, sixth and seventh months, as is clear from the production line for the eighth month falling below that of these previous three months. The ninth month, however, showed clearly an improvement in the rate to date.

The inclination of the lines giving the totals of each month also furnishes useful data. It is clear that if these lines all have the same slope, the increase from month to month is then equal. A lesser angle shows a decrease in monthly earnings and a greater angle shows a decrease in monthly earnings.

The most useful element of this form of plot, however, is the projection into the future and the ability that it gives to instantaneously correct the indications of previous periods by the result of the last period.

HENRY HESS.

Philadelphia, Pa.

Power Supply to the A. E. F. in France

In the last of his series of articles in the *Saturday Evening Post* on "Business-Managing War," Isaac F. Marcosson describes the problem of securing power for the many industrial needs of the A. E. F. in France, and of the work in this connection by a member of this Society, Maj. Dugald C. Jackson, Professor of Electrical Engineering at the Massachusetts Institute of Technology. Mr. Marcosson writes:

It must be understood that the A. E. F. is engaged in an immense industrial activity in France. We have enormous car and locomotive erection and repair shops; we build tanks; reconstruct motor transport; salvage endless equipment; occupy hospitals almost without number; operate docks; roast and grind coffee and manufacture chocolate. All this requires power, and every service clamors for it. How do we get it? * * * * *

The general purchasing agent met the emergency by establishing what is known as a technical board, one of the many activities under his supervision. The executive head of this board is Lieut.-Col. Francis E. Drake, who as chief of the control bureau is the chairman of the technical board. The active head, however, is the chief engineer, Maj. Dugald C. Jackson, a widely known consulting engineer with much experience in public utilities in America, who was a member of the faculty of the Massachusetts Institute of Technology. Associated with him from the start has been Capt. Albert B. Cudebec, a specialist in hydroelectric construction, who with Major Jackson was one of the pioneers in American Army power production in France. Gradually they have assembled a group of more than forty engineers who in civil life built dams and irrigation projects and installed power plants from the Atlantic to the Pacific. The technical board is a sort of congress of experts which, in the face of almost innumerable obstacles, has furnished the juice to drive the Army's many-sided industries.

Since it was extremely difficult to get complete new power plants from America, the board set about to develop and adapt existing French power establishments to the American needs. Wherever an uncompleted French power station was discovered American construction gangs were put to work to complete it. Every possible makeshift was employed, all to the end that power be secured. The general purchasing agent learned that some Swiss turbines intended for Russia had not been shipped. They were immediately secured and installed by American engineers in a French power station. Our purchasing representatives scoured all Europe for installations. A complete plant was discovered in Portugal. Within sixty days it was driving machinery up in the advanced section. The technical knowledge required for all this adjusting and adapting frequently had to be supplemented by tact of the highest order, for the reason that these undertakings involved rival French commercial interests, which were jealous of their prerogatives and which had to be reconciled to the larger obligation that both France and America were being served by this expansion.

The technical board is on the job day and night and it has met emergencies with a degree of swiftness not surpassed on the firing line. Here is a concrete story that will show the kind of propositions that are put up to it: On September seventeenth last, Major Jackson received the following telegram from G-4—the army coördinator—at Tours: "Get 3000-kilowatt plant in Europe." It was intended for immediate and urgent use at a large base port that we are using. Within a week a plant had been located in England and in a month it was installed in France.

A huge map that hangs in Major Jackson's office at the Elysée Palace Hotel gives a comprehensive idea of the empire of power that we have helped to develop in France. We use power in exactly three hundred and twenty-eight localities. Each one of these installations is shown in a concrete way. The master color for steam-generating plants is green, and hydroelectric service is in blue. Whenever the service is all-American the indication is surrounded by a red circle. In addition to this every army activity has its own color. An orange square denotes a bakery; a black square a salvage depot; a green-and-white square an aviation center; three white squares reveal a tank-building plant, and so on.

This American-developed power area means a great deal more than driving machinery in A. E. F. bakeries, salvage depots, air-service stations and machine shops. It has a significance for peace not to be overestimated. Combined with the utilization of water power, which is incorporated into our general power scheme, an immense section of France is likely to be diverted after the war from agriculture to industry. The brilliant imagination of the French has caught the spirit of what adequate power means. In this inevitable evolution you see one of the many permanent results of the advent of the American Army.

ENGINEERING SURVEY

A Review of Progress and Attainment in Mechanical Engineering and Related Fields, as Gathered from Current Technical Periodicals and Other Sources

SUBJECTS OF THIS MONTH'S ABSTRACTS

AERONAUTICS

Stability of a Parachute, S. Brodetsky (*Tôhoku Math. J.* 14, pp. 116-123, Aug. 1918). Investigates the equations of motion of a falling parachute with its load, assuming these to be rigidly connected and not to possess independent oscillations. The conditions for stability are that $A^2 > B$, and D, the depth of the center of gravity of the passenger below the center of gravity of the parachute itself, must lie between the values—

$$\tfrac{1}{2}(1-m)^{-1}\left\{A + \sqrt{A^2 - B}\right\}$$

Here $A = a\zeta$ and $B = 4[(1-m)/m][(1-m)k_1^2 + mk_2^2 - Ad_1]$; $m = W_2/(W_1 + W_2)$, where W_1 is the weight of the umbrella and W_2 that of the passenger; $W_1k_1^2$ and $W_2k_2^2$ are respectively the moments of inertia of the umbrella and the passenger about parallel axes through their respective centers of gravity and parallel to the plane of the umbrella, a is the radius of the umbrella and ζ is a constant depending on its shape (for a circular plate ζ is probably nearly equal to 4). *Science Abstracts*, Section A—Physics, vol. 21, pt. 11, Nov. 30, 1918 (No. 251), p. 449, *t*)

CEMENT AND CONCRETE

Potash in Cement-Mill Dust, Albert R. Merz and Wm. H. Ross. In view of the importance of the recovery of potash from the flue dust of cement mills, the following information as to the nature of the recombined potash thus recovered may be of interest.

The analyses have shown that in some cases potash recovered from the dust was found to consist in part of a material insoluble in acids, while its other part was soluble in acids but insoluble in water.

Further, it was found that in the oil-fired plant of the Riverside Portland Cement Company the greater part of the potash in the dust was readily soluble in water, while in dust collected at plants where coal is used for fuel it was found that the greater part of the total potash was acid-soluble, which greatly reduces its value for use as a fertilizer.

The present article discusses the origin of the water-insoluble potash in the dust and comes to the conclusion that its presence is due first to the ash of the coal and the dust carried over mechanically, but also possibly to the fact that a certain portion of the potash has been volatilized in the process of burning and has undergone a recombination during its passage from the kiln.

As a practical suggestion it is stated to be probable that the proportion of recombined potash in those dusts which contain free carbon might be reduced to some extent if more of an oxidizing atmosphere was maintained in the kilns during the burning of the cement.

Also, the experiments described in the article lead one to believe that the addition to the raw mix of a salt of sodium, such as sodium chloride or common salt, would bring about a reduction of the recombined potash such as has actually been observed at the plant of the Security Cement and Lime Company. Further, little recombination of potash with coal ash takes place in the carbon-free mixtures when lime is present.

Finally, the greater the amount of potash volatilized the lower will be the proportion that will undergo recombination in the dust.

The article is based on work carried out at the Bureau of Soils, U. S. Department of Agriculture, Washington, D. C. (*The Journal of Industrial and Engineering Chemistry*, vol. 11, no. 1, January 1, 1919, pp. 39-45, *tpA*)

ENGINEERING MATERIALS

Testing Car-Wheel and Locomotive Tires

Falling-Weight Test on Railway Tires, J. H. G. Monypenny. Discussion of the reliability of the falling-weight test as showing the conditions of a railroad tire.

The writer explains that the conditions in the ingot from which the tire is rolled, namely, the roughness of the surface, especially toward the top of the ingot, are such that any object rolled from the rough part of the ingot is apt to have an imperfect surface and to be shelly and roaky. The surface of the ingot may be folded or pitted for many reasons and small holes may be present in an ingot immediately below the skin. These irregularities would be reproduced in one way or another as surface defects in the rolled tire—usually as small seams and also as laps, these latter due to negligent forging. Similar defects might be found on the inside surface of the tire, but they rarely occur there unless badly piped ingots are used.

Now, the character of the falling-weight test is such that the tire is severely distorted in certain parts, while in others it is hardly deformed at all. The test consists in placing the tire in a running position on a heavy steel block weighing from five tons up, supported on a rigid foundation. A tup generally weighing one ton is allowed to fall freely on to it from gradually increasing heights until the tire has given, without fracture, a certain minimum deflection, the amount of which depends on the diameter and thickness of the tire and the character of the steel of which it is made.

It is of importance to determine whether the small superficial cracks which have been found to have but little influence on the actual performance of the tire will affect results in the falling-weight test.

To determine this, small bars 0.45 in. in diameter were turned from tire steel. The first bar was not notched; the second bar was notched on one side only to a depth of 0.013 in. Other bars were notched similarly to the depth stated in Table 1. The bars were gripped in a vise and broken by the impact of a pendulum hammer (Izod test). The energy absorbed in breaking the bars is reported in the table. A comparison of the first two lines shows clearly how sensitive tire steel is to even a minute notch, which

would indicate that a tire having a surface defect which is in any way equivalent to a notch is liable to break prematurely under the drop test if the part containing this defect should happen to be located in the highly stressed area under the tup.

The writer says that during the past 14 years he has had many opportunities of examining tires which failed under these tests and noticed repeatedly how small a defect was required to cause

TABLE 1 DATA OF IZOD TEST ON BARS CUT FROM TIRE STEEL

Depth of notch	Energy absorbed in ft.-lb.
Unnotched	200
0.013 in.	23
0.030 in.	16
0.062 in.	7
0.125 in.	3

a high-tensile-steel tire to break, provided the defect happened to be in a critical section.

On the other hand, he claims that the question as to what influence such a defect would have on the life of a tire if it were undisclosed by the drop test, as frequently happens, can be answered easily.

Car and engine tires are machined on the inside and on the tread and flange and in many cases all over before being put into service and the majority of surface flaws would be completely removed during this operation, while flaws of this nature which have not been so removed would be visible on the machined surface.

The conclusion to which the writer arrives is that a tire should not be drop-tested in the rolled condition when it still carries the sins of the ingot and every other neglect or defect of manufacture. He urges that the drop-testing of tires should be done in such a manner that a tire is tested in the condition in which it is put into service. The only possible objection to this would be the waste of the machining costs if the tire failed to pass the test, but it would prevent the scrapping of good material which now takes place due to the condition stated above.

Attention is also called to another type of flaw, the effect of which is often overlooked. This is due to the series of stamped marks on the front of the tire. While it may be necessary for the railway companies to identify the tires they put into use, it is questionable whether it is equally necessary to have the life history of the tire from its infancy of molten steel onward stamped in half-inch letters round its face.

Steel used for tires is easily broken when notched and it would seem advisable to avoid lettering as far as possible. In fact, the writer shows in a photograph an instance where the fracture has probably been materially helped by the deep stamp marks. These stamp marks affect also the life of the tire as they are not removed during machining, but remain as very favorable places for starting points of cracks. (*Engineering*, vol. 106, no. 2759, November 15, 1918, pp. 545-547, 8 figs., *epA*)

Behavior of Hollow Building Tiles Under Strains

Tests of Hollow Building Tiles, Bernard D. Hathcock and Edward Skillman. Originally hollow building tile was used mostly for its fire-resisting properties, but, as its other advantages have become more generally recognized, its range of usefulness has been greatly broadened until today it is an important structural material. And, as a consequence of the rapid growth of its use and the relative lack of definite and reliable information of its strength, the tests described below have been made by the Bureau of Standards.

Tiles are molded of clays which are quite diversified in their properties, and, after drying, are burned in downdraft kilns at a temperature well beyond initial vitrification of the clay, but rarely high enough to complete vitrification. These methods introduce variables, especially of color and porosity, which are of great importance because of their relation to the strength properties of the tiles, and have been given consideration in the classification of the tiles of these tests. It is a well-known fact that in a downdraft kiln the upper courses of the tiles are heated to a higher temperature than the lower ones. This gives the top tile a higher degree of burning, those near mid-height a medium degree of burning, those near the bottom a low degree of burning. In general, the high-burned tiles are dark in color, the medium-burned of medium shade, and the low-burned light. However, this is not always true, for the natural color of some clays or the presence of coloring matter will cause a variation.

The tests of this paper are limited to those of compression and absorption. The total number of those performed is approximately 250, of which the majority were upon tiles in compression. Stress-strain readings were taken upon 114 of these for moduli of elasticity determinations. About 70 absorption tests were made upon samples taken from tiles previously tested in compression. All the tiles were graded according to their color as dark, medium, or light, corresponding to the variations produced as described above. The tiles tested were made, with few exceptions, from clay of the buff-burning variety, and the colors given indicate variations in the buff color.

Previous to testing the tiles, their sectional areas and weights were determined. The former was done by measuring the walls and partitions with calipers and computing the sectional area from these measurements. Then they were capped with plaster of paris, to insure a uniform bearing in the testing machine. Small brass plugs were also set in some of the tiles for compressometer readings. The type of compressometer used was the 6-in. Berry strain gage, and readings were taken with it near the four corners of every tile upon which stress-strain relations were desired. The testing machines used were of the Olsen universal type.

The absorption tests were made upon three samples selected from each tile upon which the absorption determination was desired. The tiles from which these samples were taken had been previously tested, in compression.

The results of the compression tests with moduli determinations show that the strain produced by loading a tile is approximately a linear function of the applied load until failure is approached, or in other words, the modulus of elasticity of a tile is practically constant until failure. This indicates also that there is no definite proportional limit for tile; that is, the proportional limit is coincident with failure.

Tiles were tested on end, on edge and flat, and the results show that in general a tile develops both the greatest unit strength and greatest total strength when it is laid on end. The relation between the moduli of elasticity of tiles and their compressive strengths is somewhat variable, or the tile having the highest modulus of elasticity may not have the greatest strength, but in general, if the modulus of elasticity is high it is to be expected that the compressive strength of the tiles will also be relatively high.

There was found to be no definite relation between the loads at the incipient failure and the maximum loads sustained by the tiles. In some cases the incipient failure occurred early in the tests, but in other tests no notice of failure was observed until the maximum loads were reached.

There is shown to be relationship existing between the colors of the tiles and their compressive strengths and the moduli of elasticity. The dark and medium-burned tiles have about the same relative compressive strengths and moduli of elasticity, while the same properties of light-burned tiles are on an average much lower.

From the results of the absorption tests it was found that the maximum compressive strengths vary approximately inversely with the percentages of absorption. Also the percentages of absorption of the tiles vary with their colors. In general, the darker the tiles the lower the percentages of absorption are likely to be, but this is not always true because either the material or the artificial color of the tiles may often be deceptive in this respect. (Abstract from Technologic Paper No. 120 of the Bureau of Standards; *eA*)

FUELS AND FIRING

Properties of Liberty Fuel and Results of Economy Tests. Some time ago an official statement was given to the press from a bureau of the War Department claiming that a new fuel had been invented by one of the officers of the department.

The basis of the fuel is kerosene treated with a chemical, with the result that its oxygen content is increased so that when the fuel is vaporized and admitted to the engine cylinder there is present some of the oxygen needed for the process of combustion.

Fig. 1 gives the distillation curves of different grades of Liberty fuel. It has a variable specific gravity according to its varying quality. The heat value per gallon is 127,900 B.t.u., which is somewhat higher than that of commercial gasoline. (*Power*, vol. 49, no. 1, January 7, 1919, p. 9, 2 figs., *d*)

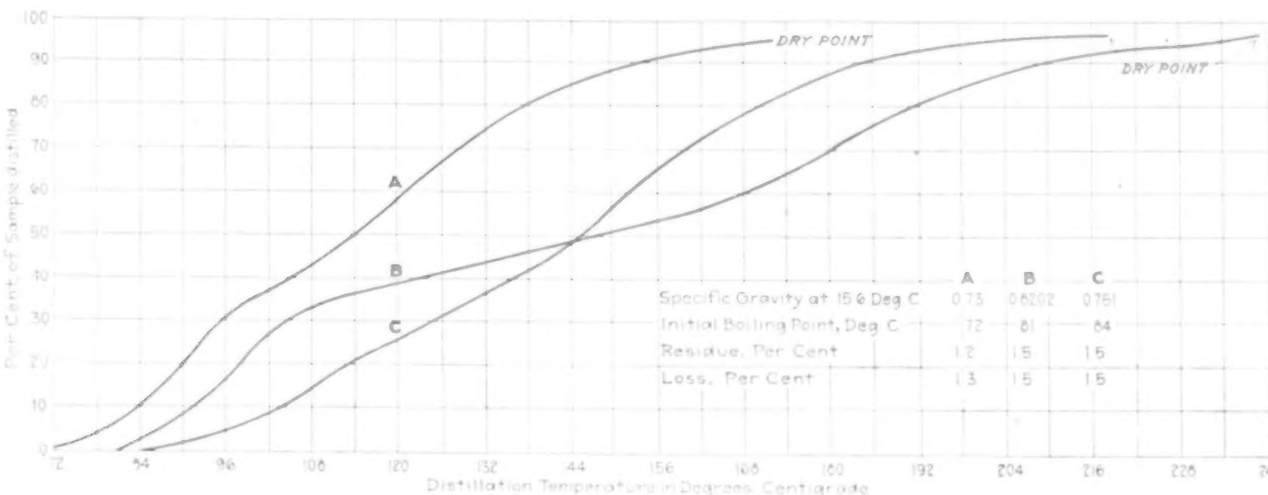


Fig. 1. Distillation Curves of Different Grades of Liberty Fuel

Note:—From data published since the appearance of the article abstracted here, it appears that the so-called Liberty fuel is a mixture, in various proportions, of kerosene and benzol, with addition of slight amounts of amyl acetate.

Efficient Burning of Indiana Coals

Burning Indiana Coal on the Chain Grate, T. A. Marsh, Mem.Am.Soc.M.E. The changes in coal distribution due to war conditions have brought Indiana coal to markets where its characteristics were not understood and the existing furnaces not suitable for efficient burning.

In Table 2 are given the analyses for standard Indiana coals which cover screenings but not run-of-mine or lump coal.

No. 3 coal, while not high in heat value, has the highest percentage of volatile matter and is excellent coal to use to get capacity in furnaces that are deficient in ignition arches or draft. It is not, however, a good coal to store both because it disintegrates easily and because of its high percentage of sulphur.

No. 4 has the greatest commercial value of all Indiana coals. Its heat value is relatively high for a western coal, the sulphur content low and the fixed carbon of such good structure that when used in by-product ovens excellent coke is produced. It is also well adapted for stoker uses, particularly with stokers that agitate the fuel bed.

From the point of view of steam production No. 5 stands at the head of Indiana coals, mainly on account of the large quantity produced, certainty of supply, uniformity and free-burning characteristics. On the other hand, as the coal has practically no clay mixture, the clinker produced is extremely vitreous. The coal is suitable for chain grates but the furnace must be such as to allow good strong ignition.

No. 6 cannot be used at all unless with a proper type of stoker, owing to the large amount of clinker produced and its vitreous structure.

As regards the design of furnaces for use with Indiana coals, the following suggestions are made:

Large grate surfaces should be provided as these coals are relatively inert. Also ample draft must be provided. These coals can be burned at combustion rates of 40 to 45 lb. per sq. ft. of grate area per hour with a draft of 0.4 to 0.5 in. over the fire.

Long, high-pitched ignition arches should also be provided and the furnace volumes should be large. In furnaces where 40 lb. of coal per hour per sq. ft. of grate area are to be burned, the furnace chamber should have a volume of 12 cu. ft. per sq. ft. of grate area, and furnaces even larger are desirable.

As regards the grates, it is claimed that large grates should be installed and the author shows a preference for grates of the chain type as they are claimed to reach excellent efficiencies at from 50 to 75 per cent of rating.

Several types of modern settings capable of producing high ratings and high efficiencies are shown in the illustrations in the original article. A prominent characteristic of all of these settings is the large volume of the furnace—from 12 to 13 cu. ft. per sq. ft. of grate area as compared with 3 to 6 cu. ft. per sq. ft. commonly found prior to 1916.

Analyses of Indiana Screenings

	No. 3 Seam	No. 4 Seam	No. 5 Seam	No. 6 Seam
Moisture	10.8	12.4	10.1	11.0
Volatile matter	35.0	33.2	33.2	31.1
Fixed carbon	36.9	44.2	42.0	41.5
Ash	17.3	10.2	14.7	16.4
B.t.u., commercial	10,400	11,069	10,820	10,540
B.t.u., dry basis	11,670	12,610	12,039	11,730
Sulphur	4.55	1.75	4.27	3.50

From this point of view it is interesting to compare Fig. 2 with Fig. 3. The former represents the designs of a furnace installed under the Stirling type of boiler 12 years ago, and the latter a recent revision of the same furnace. With the original furnace only the better grades of Indiana coals could be used. In the improved setting one continuous arch, 7 ft. 6 in. long, replaces the old sprung arch. After the revision it was found that the lower grades of Indiana coals could be nicely handled, inasmuch as the draft and grate area were adequate and the ignition was better.

From the foregoing discussion the following conclusions are evident:

1 Indiana coals are being and will be extensively used.

2 The characteristics of some of these coals are low fusing

temperature of the ash, great tendency to clinker, and large amount of clinker.

3 These coals give serious clinker trouble when the fuel bed is agitated. Continuous ash removal is preferable. With chain grates in modern furnaces, high capacities and efficiencies can be obtained from all grades of Indiana coal.

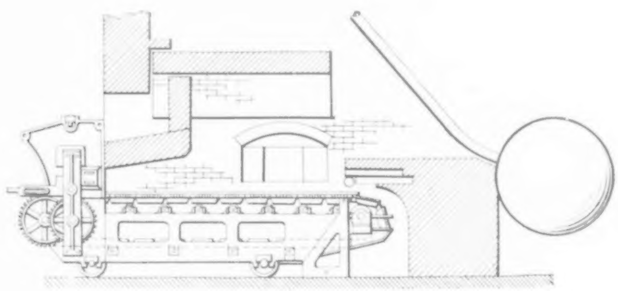


Fig. 2 Furnace Design 12 Years Ago

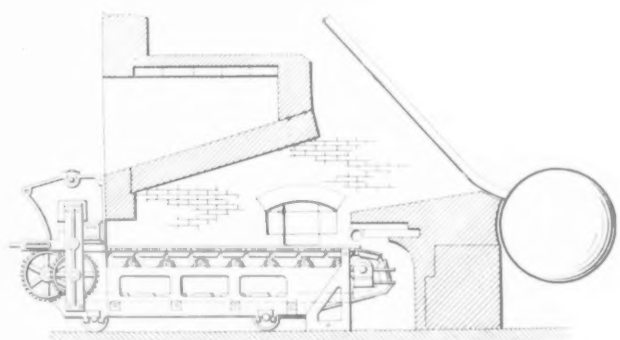


Fig. 3 Revision of Furnace Shown in Fig. 2

4 Existing furnaces permit improvement. Each should be considered in the light of modern engineering knowledge and can be revised, widening the range of coals to include all Indiana seams and increasing the capacity and efficiency under all conditions. (*Power*, vol. 49, no. 1, January 7, 1919, pp. 17-19, 7 figs., *dt*)

MACHINE SHOP

Safety Precautions in Use of Cutting Lubricants

Skin Diseases Produced by Cutting Lubricants and Cooling Liquids. This abstract is taken from Bulletin No. 2 of the Scientific and Industrial Research Department, Great Britain, entitled Memorandum on Cutting Lubricants and Cooling Liquids and on Skin Diseases Produced by Lubricants.

The skin disease produced by lubricants are mainly in the nature of oil rashes and may be due to two principal causes:

1 *Blocking of the glands of the hair follicles.* The mixture of oil and dirt blocks the minute openings of these glands and sets up inflammation around the hairs (*folliculitis*). Inflammation starting in this way may lead to suppuration or abscess formation. If many hairs are affected in this way the arm presents the appearance of a crop of red spots with a black spot as a center, or a yellow head in the case of abscess formation.

2. *Mechanical injury to the skin by metallic particles.* This may be caused by the minute metallic particles suspended in the cutting lubricant, and occurs chiefly on the hands where two surfaces are rubbed together, e.g., between fingers. Injury to the skin may also be produced on any part of the hands and arms by wiping with a cloth or rag while the hands or arms are coated with a film of fluid in which metallic particles are suspended. The cuts in the skin allow germs to enter and may lead to septic infection.

The prevention lies in keeping the worker, the lubricant and the machines clean.

Washing accommodations must be provided on a liberal scale for workers in contact with oil. Hot water, soap and scrubbing brushes are essential. Workers should be instructed not to wipe their hands on rags before washing and to avoid washing their hands in the cutting compounds.

Ether soap which dissolves oil has been found useful in preventing inflammation of the hair follicles. Dusting the arms with a powder containing equal parts of starch and zinc oxide before commencing work prevents the action of the oil on the skin.

As regards the lubricant, care must be taken in the handling of the constituents before blending to prevent such changes as formation of free fatty acids. Also the constant removal of metal particles is necessary, which, by the way, cannot be achieved either by such filtration as is provided on the machines or by centrifugal action.

Where straight oils are used their viscosity can be diminished by heat sufficiently to allow the particles to sink without affecting the value of the oil as a lubricant.

It is stated that various antiseptics (e.g., carbolic acid in a proportion of 1 to 2 per cent) have been added to the lubricants to prevent rashes, but the results obtained have not been entirely satisfactory.

Sterilization by heat has also been attempted with apparently satisfactory results, but the actual temperature required to produce this germicidal action in the oil has not yet been determined.

Workers whose hands have been affected by septic infection should not be allowed to work on machines as they are liable to infect the oil with germs, and so infect others.

Certain individuals appear to be particularly susceptible to the action of lubricants. Such persons when found should be removed from contact with oil. (Abstracted through *Mechanical World*, vol. 64, no. 1661, November 1, 1918, pp. 207-208, *gp*)

Elliptical Gears Built Up From Segments, Robt. Mawson, Mem.Am.Soc.M.E. Description of the tools and methods used in machining a special type of elliptic gearing such as used in the movement of the printing bed of the Whitlock "pony" print-

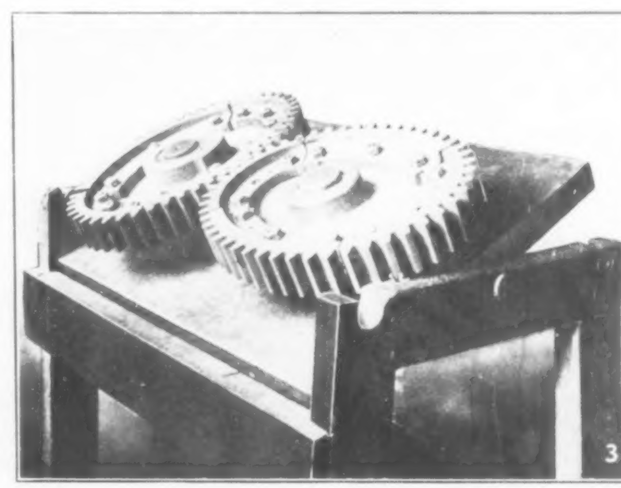


Fig. 4 Assembling Stand for Elliptical Gears

ing press. The gears used for this purpose are built up from segments which have been cut separately and are then bolted to a flange or web.

A special jig, shown in the original article, is used for drilling this web. The segments have corresponding jigs to locate the holes necessary to bolt them to the web. Finally, an assembling stand such as shown in Fig. 4 is used, and this can be set at any convenient angle to enable the operator to handle the job in the most efficient manner. The tilting baseplate has two fixed studs located at the proper center distance upon which the flanges or webs are placed and mating segments bolted to each of them. These two segments then receive such slight adjustment as may be necessary and by filing off the high spots are made to work smoothly together. Similar treatment is applied for each addi-

tional segment until the completed gears may be rotated without appreciable backlash or binding.

Since it is absolutely essential that every part of a printing press is in proper relation to every other part, the location of the keyway in these gears is determined after the gears are finished. A special feature employed in this connection is shown in the original article. (*American Machinist*, vol. 50, no. 2, January 9, 1919, pp. 61-62, 4 figs., *e*)

SOLDERS FOR ALUMINUM. The use, serviceability, method of application and composition of solders for aluminum are discussed in the light both of special tests made at the Bureau on commercial and other compositions of solders and of general experience with them. All soldered joints are subject to rapid corrosion and disintegration and are not recommended except where protection from corrosion is provided. Suitable compositions for solders are obtained by the use of tin, with addition of zinc or both zinc and aluminum within wide percentage limits. (Abstract from Bureau of Standards Circular No. 78; *p*)

MARINE ENGINEERING

Reinforced-Concrete Ship of Plate Construction

THE WALLER SYSTEM OF REINFORCED-CONCRETE SHIP CONSTRUCTION, W. Noble Twelvetrees. Description of the methods of ship construction evolved by Capt. J. H. de W. Waller of the British Admiralty, formerly a civil engineer of Dublin, as applied at the Lake Shipyard, Poole.

The characteristic feature of this system is the employment of precast plates in combination with frame members molded *in situ*.

The precast concrete plates are molded in open air on a series of concrete beds. The network of bars for each plate is assembled in a timber frame. The upper face of each plate is troweled while still green and after it has been covered with a coat of whitewash the next plate is molded upon it, the process being repeated until the stack of plates has reached the limit of height for convenient handling.

The work on the slipway is likewise quite simple. The plates forming the sides, bottom and deck of the ship are prepared and seasoned in advance, and therefore have merely to be erected and stayed in place. The only molds required are those for the longitudinal and transverse members of the framework. In order to provide secure anchorage between the several elements the plates are cast with the reinforcing bars projecting along all four sides and arrangements are made for the intermeshing and interlocking of these bars with those of adjacent plates and of members molded *in situ*.

A noteworthy feature of the vessel now under construction is the concentration of the main longitudinal reinforcement for withstanding hogging and sagging stresses in the bilges and gunwales. In fact, the vessel is designed somewhat on the lines of a through girder bridge, the principal longitudinal stresses being taken by the parallel girders constituting the sides of the vessel.

The principal transverse stresses in the deck and bottom are resisted by the transverse frames. The transverse bulkheads at the ends of the holds are built up of precast plates with counterforts extended at the foot and head to a width of 4 ft. 6 in. from the vertical axis. These counterforts are spaced 4 ft. apart transversely, and are of monolithic connection in each case with three of the transverse frames at the top and bottom of the hold. Consequently they form part of the main framework and provide secure support for the decking between or at the ends of the hatchway coamings.

Fig. 5 shows a general section through the frames. Among other things, it exhibits the curved form of the frame, which is a departure from usual practice. It is claimed, however, that this form is not only conducive to strength, but distributes more effectively the deformation of the frames and so reduces the tendency of the skin to rupture.

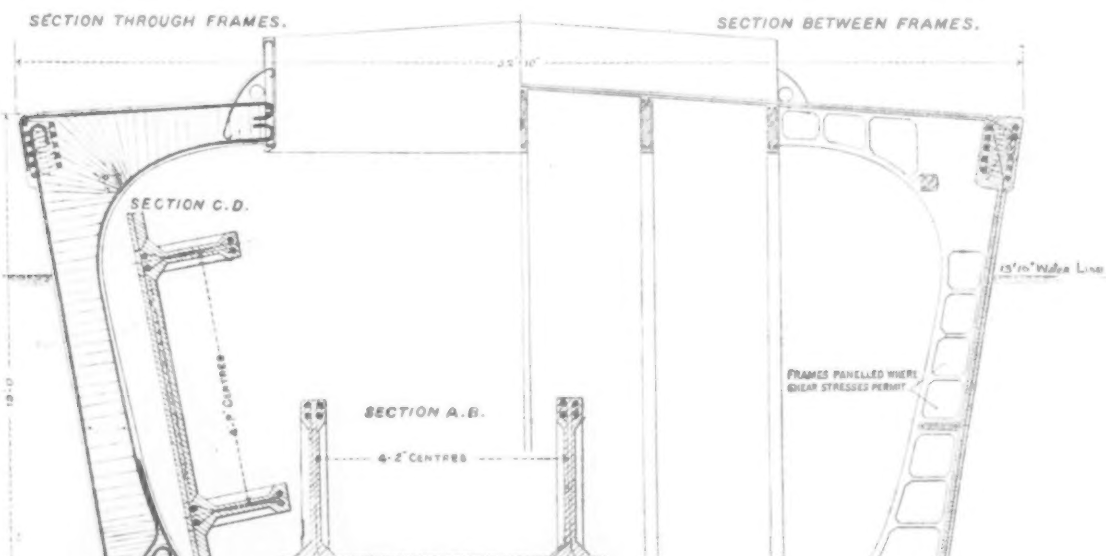


FIG. 5 SECTION THROUGH FRAMES OF WALLER TYPE OF REINFORCED-CONCRETE SHIP

The chief objection against the employment of precast units joined together by frame members molded *in situ* is that the joints may be broken by the hogging, sagging and twisting stresses on the vessel at sea. The reply of the adherents of the precast system is that joints actually exist even in vessels which are theoretically monolithic. The positions of such joints are not predetermined, however, but are governed by circumstances demanding the interruption of concreting work from time to time, and are therefore in a less favorable position than joints in the precast system, the location of which is always predetermined and selected so as to be in the most desirable places. In the Waller system, in particular, the arrangements are such that the principal stresses are assumed to be resisted entirely by the main framework which is molded on the monolithic principle, while the plates though help-

ing in resisting the shearing stresses are mainly intended to act as the skin of the vessel, being analogous to the plates of a steel ship.

It is claimed on behalf of the Waller system that a considerable saving in timber and skilled labor can be effected, because shuttering of the skin is entirely eliminated. Also, unskilled labor is economized, because the concrete of the plates is deposited at ground level, being poured quickly into open molds instead of being inserted and rammed with some difficulty between double shutters already packed with steel. It is stated that on a 1000-ton barge forty men working at once is an ample number. In a barge of 1000 tons dead-weight capacity some 200 plates are required. One plate can be cast daily on each molding bed. Therefore, if forty beds are available, the plates for the entire skin including bottom, sides and deck plates could be produced in six working days. In fact, it is believed that it will ultimately be possible to erect and concrete the hull of a 1000-ton barge in six weeks. (*Engineering*, vol. 106, no. 2760, November 22, 1918, pp. 580-583 and 586, 15 figs., *dA*)

Ship Ventilator Cowls, H. E. McCauley. Description of the processes of manufacture of ship ventilator cowls, including data on their design as used in the shops of the Sun Shipbuilding Company at Chester, Pa.

There are two types of ventilators in common use on shipboard. One has the joints crosswise on the length of the cowl between the sections that go to its make-up. This is usually called the American type of ventilator cowl. The other type of cowl is known as the European. In it the seams run lengthwise and this type is generally used for the larger sizes with mouths from 36 in. up to 84 in. in diameter or larger.

The method of laying out the templets for this type of cowl is described in the article in some detail. The article also describes and illustrates step by step the entire process of manufacture and gives an idea of the templets and forms used. (*American Machinist*, vol. 50, no. 2, January 9, 1919, pp. 47-51, 15 figs., *d*)

MEASURING INSTRUMENTS

Notes on Steam Meters, E. Claassen (*Zeits. Vereines Deutsch. Ing.* 62, pp. 521-526, Aug. 10, 1918). Though the mere provision of steam meters has a considerable indirect effect in securing steam economy, those hitherto used have conformed imperfectly to the desideratum that they should be both accurate and of rugged construction. Many types of meters yield poor accuracy, while others require skilled attention to keep them in order. Great numbers of St. John steam meters are used in America. The construction is very simple, the principle employed being that the lift of a cone opens a great or smaller steam passage according to the steam flow. In order that the lift of the cone may be directly proportional to the steam flow, the generating line of the cone's surface is made slightly curved. With a right cone, double the lift permits less than twice the flow, owing to the relatively smaller free openings; on the other hand, the increased pressure difference tends to pass more than twice the steam flow. The former factor is predominant, and to correct for it the surface of the cone is corrected by trial and error during the calibration of the meter. Calibration is therefore tedious and costly, twenty or more condensate tests often being required before sufficient accuracy can be obtained. Yet more serious is the fact that considerable errors are introduced by friction in the stuffing box through which passes the rod connecting the cone to the recording pencil. The author gives data from his own and other tests on this matter. Mere substitution of a ground spindle effects only temporary improvement if there is opportunity for scale to deposit on the metal.

One pattern of the Claassen steam meter is shown in the original article, and also the special type of packing employed. The tapered, ground-in spindle has very little friction and has proved satisfactory during 6 years' practical experience. Official test data and particulars from actual installations are given in the original. The meters are standardized by the Normal Eichungskommission (Charlottenburg). A particular meter showed the following variations from the mean constant: —2.2 per cent at 9 mm. lift; + 1.9 per cent at 43 mm. lift; and + 0.4 per cent at 58.6 mm. lift; thus the error was well within the permissible limits even at 1/7 of the maximum steam flow. A double meter used in a paper mill at Okulowka records accurately from 1000 to 11,000 kg. per hr. on one instrument, and up to 22,000 kg. per hr. when both meters are in commission.

Pressure loss in steam meters is an important factor in all except heating installations, where it is immaterial, since the energy corresponding to the pressure drop is converted into heat. The cone of the St. John meter is so heavy that it causes a pressure drop of 0.25 atmosphere, compared with 0.05 to 0.08 atmosphere in the Claassen meter. The lower the pressure drop in the meter, the more important it is to reduce friction in the packing to a minimum. The possibility of willful tampering with the packing must be borne in mind; tampering with the Claassen meter is impossible. (*Science Abstracts*, Section B—Electrical Engineering, vol. 21, pt. 11, Nov. 30, 1918 (No. 251), pp. 391-392, *g*)

MECHANICAL PROCESSES

Reversed Heads in Pressure Vessels, J. Leslie Lane. The writer questions the advisability of the use of reversed bumped head in boilers and pressure vessels generally.

The objectionable feature of such a head is that when the tank is set vertically it is next to impossible to drain it completely. Further, the dead space thus created serves as a settling chamber where oil and sediment can collect. This could be overcome only by demanding that tanks so constructed should be set horizontally.

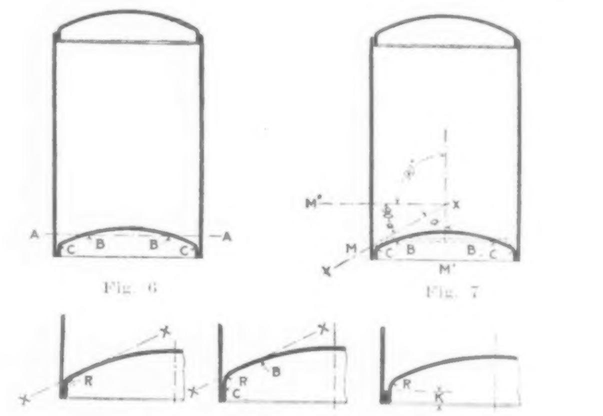


Fig. 6 Fig. 7 Fig. 8 Fig. 9 Fig. 10

Figs. 6 to 10 Diagrams Showing Action of Forces in Dished Heads

The calculation of safe pressures is a comparatively simple matter, although somewhat complicated by the presence of a bending movement at the point where the flange and the head proper join. A calculation of the capacity of a bumped head to resist collapsing pressure is more difficult, as it is somewhat analogous to buckling in bars, which latter is determined only by approximate empirical formulæ.

The writer points out that the behavior of the head under pressure depends also on the individual workmanship and the accuracy with which the head is shaped to a given radius.

If the curvature of the head is exactly the same at all points on the sphere the stresses set up in it are balanced and the flat spots needed to give the leverage for collapsing are absent. On the other hand, if there is such a leverage its action is accumulative.

Where the pressure is on the concave side such a fault tends to correct itself by forming the head to a circle; in a reversed head it tends to accentuate itself and to lead to a failure of the whole.

This makes high-grade workmanship absolutely necessary. The uncertainty as to the actual stresses present led to a stipulation that such heads shall have a minimum thickness considerably greater than would be the case if they were put in in a regular manner and the pressure applied on the concave side.

The following passage taken from the original article is of interest:

Turning to Fig. 6, observe what form the bumped head will first

assume when a distorting pressure is applied and what stresses it will develop in the shell. The problem is similar to buckling in a beam, and whatever distortion disappears will be about the neutral axis *AA*, no effect being noticeable at the points *B* where the axis cuts the head.

If the part *BB* is to bulge outwardly finally, it must first be flattened, the part *BC* of the head being distorted and assuming the shape shown in Fig. 7. This places the part *BC* in compression and the stress will be exerted along the tangential line *XX*. Without attempting to determine the exact intensity of this stress, assume it to be *M* pounds and resolve it into its two components, one parallel to the axis of the shell, the other at right angles to it.

Supposing that the line *XX* makes an angle a with the axis of the shell, then the force M' acting parallel to the axis of the drum will be $M \cos a$ and its effect will be wholly exerted on the rivets holding the head in position. The force M'' acting at right angles to the axis of the drum will be $M \cos$ (90 deg., a) and its effect will be partly exerted on stretching the metal in the part *BC* of the head, and in expanding the shell of the drum itself. To put the proposition in a simpler way, the action is a toggle effect, the outer rim of the head being stretched and forced out against the shell, tending to rupture it.

Just how much of this toggle effect is brought to bear on the shell of the drum depends on the radius *R*, where the head meets the flange. If the radius is small, as in Fig. 8, then any expansion of the head must affect the shell, for the thrust comes directly against it. On the other hand, if this radius is large, as in Fig. 9, the part *BC* of the head is free to spring and the stretching of the shell is minimized. This would lead to the conclusion that in reversed heads the radius at the knuckle of the flange should be considerably larger than in the case of straight dished heads of the customary type. In order to reduce still further this toggle effect, the writer believes it would be advisable to insert a filler piece between the flange of the head and the drum, as shown in Fig. 10. It need not be thick—probably one-eighth inch would be sufficient—and where possible it would be of copper. Its width *K* should not exceed $2\frac{1}{2}$ in., in order that a clear space be left above to take care of any expansion of the head.

The writer sums up the advantages and disadvantages of the reversed head and comes to the conclusion that where safety is a necessary factor, the reversed head should not be used. (*Power*, vol. 49, no. 2, Jan. 14, 1919, pp. 61-62, 5 figs., *ptA*)

Manufacturing Marine Steam Boilers, E. A. Suverkrop, Mem.Am.Soc.M.E. Description of the processes used in the boiler shop of the Sun Shipbuilding Company, of Chester, Pa. The boilers manufactured are of the so-called Scotch type, single-ended, with three furnaces.

The article, which is profusely illustrated by photographs and line cuts, describes in general the layout of the boilers, the rolling of the shell plates to the desired curvature, the location and boring of the holes, the flanging and all subsequent operations in considerable detail.

Among other things are described in some detail the tools used by the company in the manufacture of the boilers; in particular, the rolls and the flanging press. The flanging machine also does the work of forging or upsetting the ends of the large staybolts used in these boilers.

The article is of interest in that it gives a broad view of the operations involved in the manufacture of a large marine boiler. (*American Machinist*, vol. 49, no. 26, December 26, 1918, pp. 1155-1163, 21 figs., *dA*)

MECHANICS

Hardness: Its Nature and Measurement

Hardness, James J. Guest. The paper here abstracted was presented in the form of a discussion on the paper by R. G. C. Batson entitled The Value of the Indentation Method in the Determination of Hardness, at the November 15 meeting of the Institution of Mechanical Engineers in London.

To indicate the nature of hardness the author sketched the stress-strain diagram reproduced in Fig. 11 with the curve distorted for the sake of clearness but generally typical.

In Fig. 12 is shown a tool penetrating the material. The author pointed out that the state of stress in the material would vary throughout, the states of stress at *a*, *b*, *c*, *d*, *e* corresponding in type to those represented at *A*, *B*, *C*, *D*, *E* in Fig. 11, though the stress within the material would be complex. In addition to this there would be a surface of discontinuity, as marked, through *b*. Outside this surface the material would possess elastic strain energy, within it there would be overstrain, involving lost energy, combined with elastic energy, and in the tool elastic energy only. The tool was supposed to be acted upon by the force *P* indicated.

A tool of any conical shape, as that sketched, did not involve any linear dimension, and hence in the position shown there was only a single linear dimension involved, which was the diameter *d* of the indent. Hence, the tool being in equilibrium under the

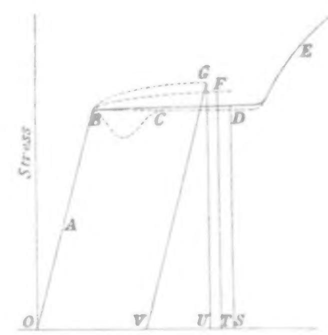


Fig. 11 Stress-Strain Diagram of Hardness Test

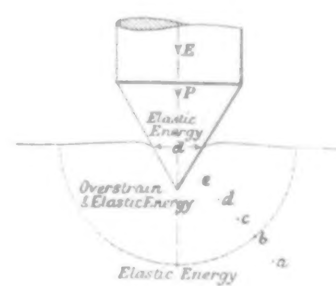


Fig. 12 Tool Penetrating Material in Hardness Test

Fig. 13 Diagram Showing Surfaces of Contact between the Tool and Material in Hardness Test with Varying Depths of Impression

force *P* and the reaction due to the stress condition in the material, there must be a relationship involving *P*, *d*, and certain complex stresses and elastic constants of the material, represented under the head p in the summation equation:

$$P = \Sigma A d^k p^l \ldots\ldots\ldots\ldots\ldots\ldots [1]$$

As throughout p was of the dimensions of stress, by dimensional theory the only possible values of the indices were $k = 2$ and $l = 1$, and therefore P/d^2 must be a constant for the material.

Referring again to Fig. 11, along *O*, *A*, *B*—the Hooke's law portion—the relationship of stress and strain was independent of time, but near and beyond *B* a time effect showed itself, the curve taking such forms as indicated by the broken line, the metal having a semi-viscous flow. Hence Equation [1] would not be quite true and the value of P/d^2 would not be quite independent of the time. But from the known proportions of phenomena represented typically by such curves it was clear that P/d^2 was the predominant factor in the law of indentation.

Mr. Guest then considered the case of an impact test, Fig. 12 again representing the case of a tool applied with energy *E*, the

corresponding summation equation for the indentation being:

$$E = \Sigma B d^m p^n \ldots\ldots\ldots\ldots\ldots\ldots\ldots [2]$$

The indices again had single values, $m = 3$ and $n^* = 1$, so that E/d^3, was necessarily a constant for the material.

The stress-strain diagram in Fig. 11 represents a slow test. The effect of a rapid application of the load is to raise a portion of the curve beyond B, as shown by the dotted curves BF, BG, and the more rapid the application of the load the higher would be the curves.

If at the point G the stress was removed, the curve fell along the line GV, the energy measured by the area $OBGV$ being destroyed, but that represented by the area GVU restored by the material. The proportion of energy reaching any element of the material varied; at points such as a in the elastic region it was practically all restored, and the proportion of energy restored gradually diminished along b, c, d, e. Except for losses—such as due to vibration—the sum of this energy (with that in the tool) appeared in the rebound energy of the hammer, so that the height to which it rebounded duly measured some complex summation determined by the elastic and stress laws of the material.

If the tool instead of being conical were of a wedge shape of indefinitely long edge, then again there would be no linear dimension involved in the tool and all the above would apply. When, however, a ball is used as a tool its diameter is involved and with varying depth of impression the similarity of the surfaces of contact between tool and material ceases, as is shown in Fig. 13. If, however, the impressions were of nearly the same magnitude, the main factor must still be of dimensions $\frac{\text{force}}{\text{length}^2}$.

The paper also contains an extensive criticism of various statements in the paper by Professor Edwards, which may be abstracted together with the original paper at a later date.

In connection with the rule that the dynamic hardness was to be measured by E/S^2, where E was the applied energy and S the spherical area of indentation, R. G. C. Batson has compared the values of the measures for the hardness obtained by dividing the applied energy by the volume of indentation V and by S^2. He plotted the quantities V and S^2 against one another, calculating them from the formulæ

$$V = \frac{\pi}{3}h^2\left(\frac{3}{2}D - h\right) \text{ and } S^2 = \pi^2 d^2 h^2$$

which he gave.

In this connection Mr. Guest calls attention to the fact that the elimination of h (depth of indentation) between these equations did not give a straight line, and the departure from straightness as represented by $\frac{2}{3}\frac{h}{D}$ is 0.067 for the data selected by Mr. Batson and 0.01 to 0.045 for the experiments with balls of various diameters made by Professor Edwards.

As regards these latter, Mr. Guest gives Table 3, in which the last two columns are added by him personally. The variation of the figures in the column E/V does not suggest dependence of the shape of the curve upon ball diameter.

TABLE 3 GUEST'S DATA ON HARDNESS TESTS

E Energy of Impact	V Volume of Indent	d Diameter of Indent	D Diameter of Ball	h Depth of Indent	S Spherical Area	C Professor Edwards' Constant	$\frac{E}{S^2}$	$\frac{E}{V}$
0.054	0.25	2.234	10.00	0.126	3.97	4.635	0.00343	0.216
0.089	0.45	2.584	10.00	0.170	5.33	4.730	0.00314	0.198
0.158	0.73	2.376	4.76	0.319	4.77	3.760	0.00697	0.217

In this connection and, in particular, in connection with the formula of J. O. Roos, Mr. Guest connected Professor Edwards' constant with the volume of indentation, writing:

$$\frac{d^4}{V} = \frac{32D}{\pi}\left(1 - \frac{h}{D}\right)^2\left(1 - \frac{2}{3}\frac{h}{D}\right)^{-1}$$

$$= \frac{32D}{\pi}\left(1 - \frac{4}{3}\frac{h}{D}\cdots\right)$$

thus showing that C^{-4} was of the same nature as the expression of Mr. Roos, but with a different coefficient for the term h/D. That the values of C tabulated varied less than the values of E/S^2 was due to the glozing over of the effect of the variation of the diameter ratio by taking its fourth root. This, however, simultaneously reduced the whole variation of the constant and hence the gain is illusory.

As h/D was small, there was little difference between E/V, ED/S^2 and $C^{-4}D$. Now the energy summation for the ball impact might, taking h the permanent indent and D as the involved lengths, be written

$$E = rD^3 + SD^2h + tDh^2 + uh^3$$

since E increased with D and h. Putting $h = 0$, $E_0 = rD^3$ was the energy which would just not produce a permanent indent. This had some value, and as it varied with D^3 the ball method was not well adapted to make "absolute" determinations. Since, to a first approximation, $4Dh = d^2$, the above equation might be written

$$E = rD^3 + S/4\,Dd^2 + t/16\,\frac{d^4}{D}\left(1 + \frac{u}{t}\frac{h}{D}\right)$$

With a given diameter of indent a small ball penetrated further than a large one, and therefore the second term was probably zero. Hence the most important feature must be the third term. The experiment work confirmed this. The above coefficients should form the aim in experimental work.

These remarks call forth a certain amount of criticism. H. L. Heathcote said that it is the opinion of Mr. Guest that the energy of the blow was equal to the sum of certain energies on the other side, namely, the elastic energy in the denting tool and the elastic energy in the specimen plus strain energy. The speaker thought that the energy required to move the metal should also be taken into account.

When experimenting with the punch referred to in Batson's paper and applying the curve showing the relation between diameter and depression produced and the Brinell numbers, the speaker had not obtained a curve exactly parallel with the curve showing in the Brinell diameter as a function of the hardness. Both were sloping curves, with the further significant characteristic that one curve crossed the other in two places. Crossing of the curves suggested that the hardness as found with the autopunch of a hard specimen was greater and that of a soft specimen less than would be found with the Brinell test. The writer claims that the Brinell test crushed a hard specimen, disintegrating the metal, and that the impact test got its work done before the crushing and softening had taken place.

Several other interesting discussions reported in the original article cannot be abstracted because of lack of space. (*Engineering*, vol. 106, no. 2760, Nov. 22, 1918, pp. 588-591, 4 figs., *tA*)

Bureau of Standards Tests of Large Brick Piers

THE COMPRESSIVE STRENGTH OF LARGE BRICK PIERS, J. G. Bragg. The following is an abstract of the report on tests of large brick piers which were made at the Pittsburgh laboratory of the Bureau of Standards in coöperation with the National Brick Manufacturers' Association.

The purpose of this investigation was to determine the strength developed by brick piers of normal size as used in modern buildings, using in their construction such materials and grades of workmanship as are available in the United States.

The variables considered in the investigation are: (1) the quality of bricks employed with respect to grade and geographical location; (2) the quality and kind of mortar; (3) the grade of workmanship employed, and (4) the bonding of courses or method of laying the bricks.

* In the original, p is erroneously referred to here.

The investigation comprised tests on 46 piers 30 in. by 30 in. by 10 ft. in height, also 4 piers of the same cross-sectional dimensions 5 ft. in height. The bricks used in their construction are representative of four widely separated districts east of the Mississippi river and are classified according to the following 3 grades;

Grade 1, Hard-burned or best quality
Grade 2, Medium-burned or considered as common
Grade 3, Soft-burned or poorest product marketed.

Three mortars were used in the beginning and three grades of bond and workmanship were employed throughout the investigation.

The mortars used were

a 1 part cement to 3 parts sand by weight
b 1 part lime to 6 parts sand by weight
c 1 part (0.15 lime + 0.85 cement) to 3 parts sand by weight.

The different methods of bonding were as follows:

a Alternating header and stretcher courses
b Header course every 4th course
c Header course every 7th course.

Wire mesh was used in two of the 5-ft. piers to study the effect of lateral reinforcing in the horizontal joints. A more than usual number of tests of individual bricks were made in order to determine the relation of the strength of single bricks to the compressive strength of piers.

The first indication of failure observed was the same in all cases and appeared in the form of small hair-sized cracks in the individual bricks. The cracks widened and extended to other courses under additional load, finally becoming confluent and extending almost the entire length of the pier. Soon thereafter final failure occurred accompanied by a spalling off of the outer ring of bricks. Very little crushing of the bricks was apparent after failure except in the case of the softer bricks laid in cement or cement-lime mortars. The cause of incipient failure of the piers is attributed to a transverse failure of the individual bricks.

The tests show that variations in the number of header courses used does not affect the ultimate compressive strength of the pier. Failure of the individual bricks by flexure would render the header courses ineffective by such time as they would be useful in preventing an outward bulging of the masonry.

The quality of brick is shown to be a very important factor in its effect on the compressive strength of the pier. The compressive strength of half-bricks flat and on edge, also the transverse strength or moduli or rupture of the bricks, are shown to be proportional to the compressive strength of the piers.

Very little difference in strength is apparent in piers of 1:3 portland cement and sand mortar and those of 1 (15 per cent lime and 85 per cent cement): 3 sand mortar. In the last-named mortar 35 per cent by volume of the cement is replaced by lime. These piers of cement and cement-lime mortars, however, developed strengths 50 per cent to 75 per cent higher than those of pure lime mortar. There is a considerable advantage in the easier working qualities of the cement-lime mortar over the pure portland-cement mortar. In consideration of the results of these and previous tests on piers of smaller cross-sectional dimensions, from 35 per cent to 50 per cent of the cement in a 1:3 cement mortar may be replaced by hydrated lime without appreciably affecting the compressive strength of the masonry; the higher percentage to be used in piers of small cross-sectional dimensions.

A study of these and previous tests indicates that lateral reinforcing in the horizontal joints is effective only when placed in every joint.

The following empirical formulæ are given for use in computing the strength of brick piers:

$$P = Kp \quad [1] \qquad P = KR \quad [2]$$

where

P = ultimate unit compressive strength of the pier
p = unit compressive strength of single half-bricks
R = unit transverse strength or modulus of rupture of single bricks
K = a constant depending upon the kind of mortar used.

The values of K are given in Table 4 for the mortars used in this investigation.

The modulus of rupture is computed according to the formula

$$R = \frac{3}{2}\,\frac{Pl}{bD^2}$$

in which

R = modulus of rupture
P = breaking load, in pounds, of a single brick in a flatwise position supported at the ends and loaded at the center
l = distance between the supports (in these tests 7 in.)
b = breadth of specimen in inches
d = depth of specimen in inches.

TABLE 4 VALUES OF MORTARS USED IN INVESTIGATION

Mortar	Values to be determined by tests of single bricks	Value of K
1 part (0.15 lime + 0.85 cement) to 3 parts sand by weight	Unit compressive strength flat $= P$	0.26
	Unit compressive strength on edge $= p$	0.30
	Modulus of rupture from transverse test $= R$	1.25
1 part lime to 3 parts sand	Unit compressive strength flat $= P$	0.11
	Unit compressive strength on edge $= p$	0.14
	Modulus of rupture from transverse test $= R$	0.65
1 part cement to 3 parts sand	Unit compressive strength flat $= P$	0.27
	Unit compressive strength on edge $= p$	0.32
	Modulus of rupture from transverse test $= R$	1.45

The complete report includes 24 figures and numerous tables. There is also a chapter devoted to previous tests giving abstracts and tables of the results from previous investigations of the load bearing values of brick piers. (Abstract from Technologic Paper No. 111 of the Bureau of Standards; *eA*)

German Analysis of the Belt Drive

MECHANICS OF THE BELT DRIVE, Dr. Wilhelm Stiel. The original article abstracted here represents in itself an abstract of a book published by the author in 1918, in which he considers the properties and modes of operation of belt drives in general, and, in particular, the relation of forces acting during the process of power transmission by belting.

In the first place, the author considers a belt drive with extremely low velocities of translation of the belt.

The only relation between the forces acting on a belt, which must prevail under all circumstances, is the condition of equilibrium, in view of which the sum of all forces must be equal to zero. As regards external forces acting on the belt pulley (neglecting the individual properties of pulley as is done throughout this discussion), there are, in the first place, the two tangential forces S'_1 and S'_2 and the axial force A, and because of the condition of equilibrium we must always have

$$A + S'_1 + S'_2 = 0 \ldots\ldots\ldots\ldots\ldots [1]$$

with the further condition that the addition of forces, as a rule, should be carried out geometrically and that only in particular cases does an algebraical addition become permissible. If we take into consideration the general equation for the effective force

$$S_n = S'_1 - S'_2 \ldots\ldots\ldots\ldots\ldots [2]$$

then we find for the axially acting force the expression

$$A + S'_1 + S'_2 + S'_2 = 0 \ldots\ldots\ldots\ldots\ldots [3]$$

For a drive with ratio [1] we have an algebraic equation

$$A = S_n + 2S'_2 \ldots\ldots\ldots\ldots\ldots [4]$$

which has a general application provided we understand that by A is meant not the axial pressure, but the sum of the tangential forces $S'_1 + S'_2$. From this it follows that the deciding constituent of the axial pressure or the sum of tangentially acting forces is the transmitted effective force, and the prevailing tendency in the variation of the axial pressure will be an increase proportional to S_n.

A modification is introduced in this connection by the magnitude of tension on the loose side, which is mainly affected by the individual conditions of each drive, and especially by the magnitude of the initial tension.

The resultant variation of the axial pressure as a function of the useful load depends, therefore, quite materially also on whether and to what extent the arrangement of the drive is capable of maintaining the tension on the off side with the increase of load, and it appears that not only the axial pressure but the entire relation of forces acting in each belt drive is fully determined by the formula

$$S'_2 = f\,(S_n) \ldots\ldots\ldots\ldots\ldots\ldots\ldots [5]$$

which means that whenever a belt drive is investigated it is sufficient to determine the S'_2 characteristic in order to secure complete information as to the general state of that particular drive.

In the arrangement a, where there is no initial pressure, we have $S'_{2a} = 0$. Hence, in that case (Fig. 14) both the force on the tight side S'_{1a}, as well as the axial force A_a, are represented

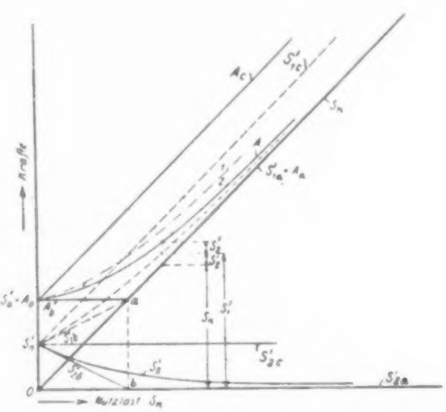


FIG. 14 FORCES ACTING IN A BELT TRANSMISSION

Ordinates: Forces (*Kraefte*); Abscissae: Useful Loads (*Nutzlast*) S_n

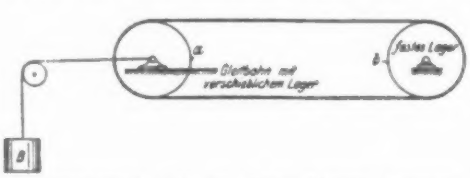


FIG. 15 ARRANGEMENT (b) OF BELT DRIVE GIVING CONSTANT AXIAL PRESSURE

(*Gleitbahn mit verschieblichem Lager*—Sliding support with displaceable bearing); *fester Lager*—Fixed bearing

by equal straight lines passing through the origin of coördinates, while $S'_{2a} = 0$ coincides with the axis of abscissæ. Such an arrangement satisfying the condition $S'_2 = 0$ is conceivable but difficult to execute mechanically as a belt drive. It appears, however, in all chain drives provided only we consider the chain itself as having no weight.

On the other hand, there may be an arrangement such as that devised by Bach and shown in Fig. 15, where the Grashof equation $S'_1 + S'_2 = 2S_0 =$ constant always holds good. In this arrangement, which is only of theoretical interest and can hardly have any application in practice, the axial force acts along the horizontal line A_b (Fig. 14). S'_{1b} and S'_{2b} lie along a line inclined to the horizontal at an angle arc tan ½.

Further, there may be other arrangements c in which the tension on the slack side is artificially maintained at a value different from zero, as, for example, in the Lenix drive. In such arrangements the tension on the slack side follows the horizontal straight line S'_{2c}, while the force on the tight side and the axial pressure are expressed by straight lines S'_{1c} and A_c (Fig. 14) parallel to the line of effective force.

In the usual arrangements of belt drive where the initial tension is created not by artificial devices, but exclusively by the elasticity and weight of the belt itself, the curves expressing S'_2, S'_1 and A are all located within the part of the diagram determined by the straight line corresponding to each of the arrangements a, b and c.

The writer gives some further indications as to the behavior of these curves which help to recognize their character.

First, all the curves S'_2 have as tangents at their origin S'_0 the straight line S'_{2b} having an angle of inclination arc tan ½ and asymptotically approach the axis of abscissæ.

Next, all the curves S'_1 have at their origin S'_0 as a tangent the straight line S'_{1b} rising at an angle arc tan ½ and asymptotically approach the lines of effective force S_n and S'_{1a}.

All the curves A have at their origin $A_0 = 2S'_0$ as tangent the horizontal line A_b and asymptotically approach the lines of effective force S_n and A_a.

In order to determine the actual course of the curve $S'_2 = f(S_n)$ given in equation [5], the writer applies a graphical method based essentially on the work of Kurtzbach and Barth.

The results secured in this manner are compared with those experimentally obtained by Lewis in 1886. These results are represented in the form of curves of average values (Fig. 16) and indicate a complete accord with what should be expected from Fig. 14.

These tests prove beyond doubt that the excessive axial pressures occur not only at high velocities, but also at very low velocities approaching a stationary state and even in the stationary state itself.

If it should be desired to secure an approximate expression for all of these relations one might make use of the observation to the effect that the curves of axial pressure plotted in Fig. 14 are in shape similar to hyperbolas. The curves of axial pressure have low initial tensions (such as in the order of magnitude up to $2k'_0 = 10$), are practically exactly equilateral hyperbolas and follow the equation

$$A = S_n^2 + 4\,S'^2_0$$

and since $A = S_n + 2\,S'_2$, it follows that

$$A = \sqrt{S_n^2 + 4\,S'^2_2} \ldots\ldots\ldots\ldots\ldots [7]$$

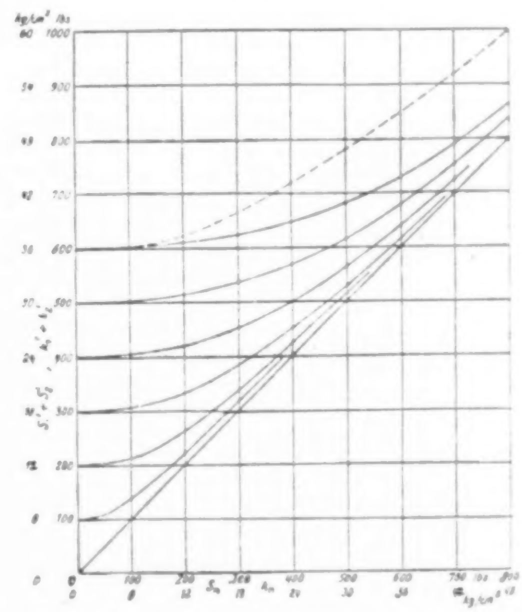


FIG. 16 $S'_1 + S'_2 = f\,(S_n)$ ACCORDING TO TESTS OF LEWIS

At higher initial pressures these equations give excessively high values as may be seen from the dotted curve in Fig. 16 for $A_0 = 36$. Hence, when these curves are used they give the axial pressures correctly but are uncertain as to the way they give the variation of S'_2. The author recommends, therefore, using the hyperbolic equation [7] only for rough calculations of the axial pressure, but not for the determination of S'_2. It should also be borne in mind that equation [7] does not take into consideration the axial distance, so that it covers only normal conditions where a does not differ much from 4.

In the opinion of the author, this formula is better than the previous assumption of constant axial pressure, and the relation established by the author has, at least, the advantage of greater clearness. This relation is: The sum of the forces acting on the side of a loaded belt equals the square root of the sum of the square of the effective load and the sum of the forces acting on the side of the belt running idle. (First part of an article in *Dingler's*

polytechnisches Journal, vol. 333, no. 18, September 7, 1918, pp. 161-166, 12 figs., *p*. The second part may be abstracted in an early issue if the space is available.)

A Relation Connecting the Derivatives of Physical Quantities, Mayo Dyer Hersey. In this paper it is shown how the theory of dimensions may be used in a differential form; a procedure which appears fruitful, particularly in investigating the effect of given sources of error on the performance of measuring instruments. The examples which led to the necessity for developing this method are discussed at the end of the paper and illustrated by experimental data. (Abstract from Scientific Paper No. 331 of the Bureau of Standards; *t*)

POWER PLANTS

Generator Wreck at St. Paul. Description of the wreck of a 2000-kw. generator on December 10, 1918, in the St. Paul (Minn.) plant of the Northern States Power Company.

The trouble was caused by a workman short-circuiting a 13,000-volt feeder in Minneapolis connecting the St. Paul and Minneapolis plants. The St. Paul plant was subjected to short-circuit of such proportions and duration that the excitation (from a motor-generator set) was practically lost on the two turbo-generators then operating, and by the time another exciter was put in operation the generator end of one of the units, namely, the 2000-kw., was completely wrecked.

The steam end of the turbine remained intact, although the shaft was probably sprung and the casting supporting the turbine bearing cracked, but the generator and its bedplate were completely wrecked.

Just how the wreck occurred is not quite clear yet. One of three things may have happened:

1 The machines being subjected to this short-circuit for several minutes caused the mechanical collapse of the 2000-kw. unit.

2 The machines remained on the short-circuit until it was cleared, and the entire system, many times 3000-kw. capacity, endeavored to bring them into step.

3 The machines under this terrific short-circuit overload dropped their load, due to loss of excitation, and the 2000-kw. overspeeded until the generator exploded.

The first assumption is unlikely, as a short-circuit located at the end of a 10-mile feeder would not wreck the machine mechanically, and the latter was not burned out electrically as no smoke or blaze was noticed.

The second assumption is also unlikely, since the 1000-kw. unit was not affected. Therefore overspeeding seems to be the most probable cause. The turbines had been in service nine years, were built for 150 lb. steam pressure and no superheat, and were actually operated under 185 lb. steam pressure, 100 deg. superheat and 6 lb. back pressure. Owing to this changed steam condition, the company operating the plant had dismantled the automatic safety stop on the three type C machines, depending upon the system to lock them electrically and load changes to be handled by the regular governor operating on the primary and secondary valves. Both of these valves were opened to the maximum on the short and the machines operating at much reduced speed. When the load was dropped, owing to this loss of excitation, the generators instantly speeded up. The governor on the 1000-kw. turbine closed its valves and kept the machine at normal speed under steam. The valves of the 2000-kw. turbine did not close tight, or for some other reason the governor did not control this machine. The overspeed trip actually tripped, but as the automatic safety stop was dismantled, it was useless and the generator reached a speed where the fourteen 2½-in. bolts per field pole were elongated and the poles struck in the stator, which twisted off the shaft and wrecked the machine. (*Power*, vol. 49, no. 2, Jan. 14, 1918, pp. 40-41, 3 figs., *d*)

RAILROAD ENGINEERING

Feedwater Heating for Locomotives

Locomotive Feedwater Heating, H. S. Vincent. Discussion of the exhaust-steam and waste-gas methods of preheating for locomotive boilers. The exhaust steam contains a greater quantity of heat than waste gases and this heat is more readily transferred to the feedwater, but only a limited amount of the steam can be diverted for heating purposes as the exhaust rate is required for helping the draft on the locomotive.

As regards waste gases, they carry off from 20 to 45 per cent of the heat in the fuel and it would seem that this great loss offers a promising field for economy. Little progress, however, has been made in this direction partly because of the slow rate of transfer

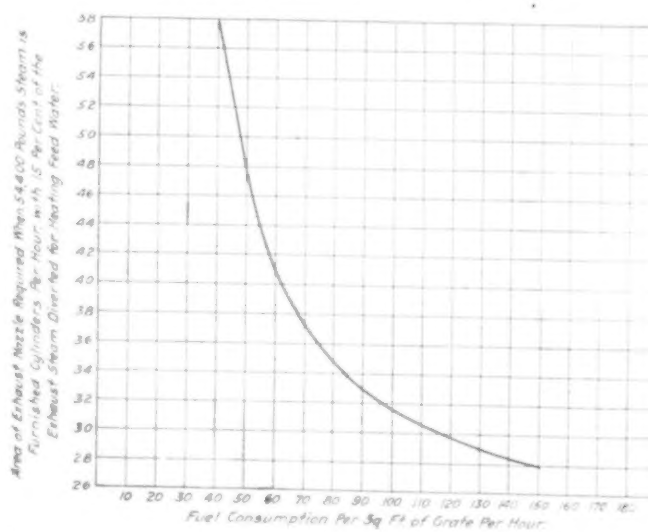


Fig. 17 Area of Nozzle in Square Inches for Various Rates of Combustion

between this heat and the feedwater and also because of other practical difficulties.

The present paper gives calculations for both types based on an equipment suitable for application to a typical high-speed passenger locomotive of which the principle dimensions and characteristics are given. The article, generally, is not well suitable for abstracting and only certain of its features will be reproduced here.

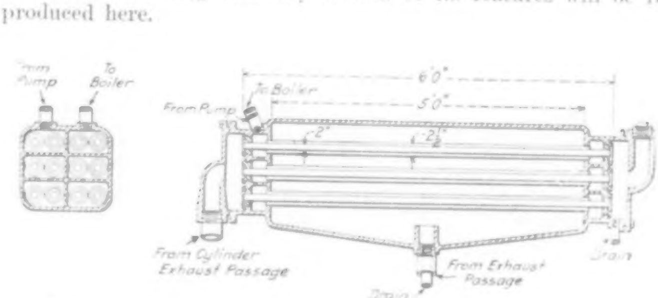


Fig. 18 A Type of Exhaust-Steam Feedwater Heater

In the first place, the author shows that the statement that a portion of the exhaust steam may be diverted for heating the feedwater without necessitating a reduction in the area of the exhaust valve, is not correct. Any decrease in the weight of steam passing through the exhaust nozzle, unless accompanied by a proportionate decrease in the amount of fuel consumed, will be detrimental, and this has been proven by extensive tests made on the locomotive above referred to.

The writer gives formulæ for determining the area of nozzle required to produce the necessary draft when diverting a predetermined proportion of the exhaust steam for such purposes as feedwater heating. Thus, in Fig. 17 are plotted the areas of nozzle in square inches for various rates of combustion, which show that these areas depend directly upon the economy given by the feedwater heater.

Fig. 18 illustrates diagrammatically the type of exhaust-steam heater in which the feedwater circulates through the annular passages between the inner and outer tubes, the heating medium flowing through the inner tube and surrounding the external surface

of the outer tube. To provide sufficient volume the pipes are arranged in pairs, six such pairs or units forming the heater. The feedwater is forced by a feed pump into the header at one end of the heater, it then flows in columns to the opposite header, traversing the entire length of the heater and flowing thence to the boiler. The heating medium (exhaust steam) is taken from any convenient point between the cylinder and the exhaust nozzle. It enters the heater at one end, flowing through the twelve internal pipes to the opposite header; exhaust steam also enters the casing and surrounds the outer pipes, the condensate being carried to any convenient point.

For a heater of the dimensions shown in Fig. 18 the total traverse of the feedwater is 30 ft. and of the exhaust steam in the inner

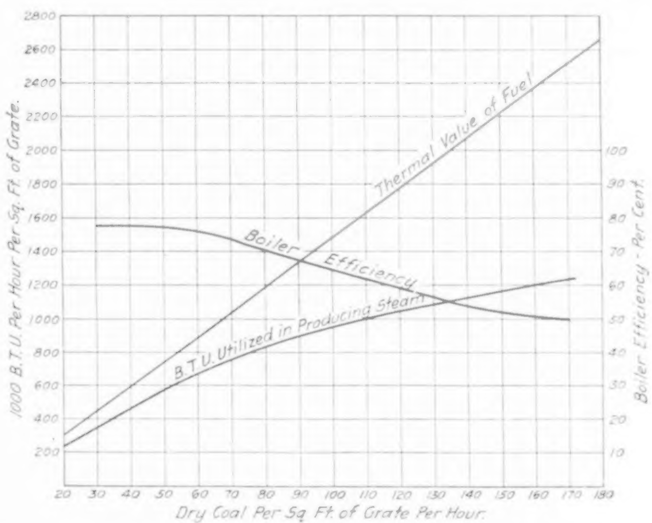


FIG. 19 EFFICIENCY CURVES OF A LOCOMOTIVE BOILER WITHOUT A FEEDWATER HEATER

channels, approximately 6 ft.; the total heating surface in tubes is 71.22 sq. ft. As a modern boiler-feed pump will deliver 100 lb. of water against a boiler pressure of 205 lb. for 1.75 lb. of steam, the total weight of water per hour passing through the heated is $54{,}400 \times 1.0175 = 55{,}390$ lb. or 15.35 lb. per sec.

The volume per foot of the annular space between a pair of tubes in the heater of Fig. 18 is 26.96 cu. in. and the weight of water at 60 deg. is 0.972 lb. per foot of tubes. The velocity of water passing into the heater is $15.35/0.972 = 15.75$ ft. per sec.

The pressure of the exhaust steam entering the heater is 13.7 lb. gage or 28.4 lb. absolute, the corresponding temepratture of saturated steam being 247 deg. fahr.

The writer discusses the determination of the amount of heat transmitted to the feedwater in its passage through the heater and gives a set of curves representing conductance values at different temperatures and at various feedwater velocities. Another diagram establishes the relation between the temperature of the heating medium and the total conductance at a feedwater velocity of 15.75 ft. per sec. which prevails in the case of the feedwater heater shown in Fig. 18.

As regards the economy secured with the heater, formulæ are given for determining the direct economy, which is the reduction in the number of thermal units which the boiler must supply. In addition to this, however, there is an indirect saving due to the diminished boiler losses resulting from the decreased fuel consumption and in this connection Fig. 19 is of interest, as it gives the relation between the thermal value of the fuel fired and that utilized in the production of steam; in other words, the boiler efficiency as determined from the tests of the locomotive. In this figure this boiler efficiency is plotted in relation to the unit fuel consumption per hour. In this instance for a unit fuel consumption of 120 lb. the boiler efficiency is 59 per cent and for a unit consumption of 111.5 lb. an efficiency of 61.6 per cent is secured, or an indirect economy of $61.6 - 59 = 2.6$ per cent, which added to the direct saving previously found to be 7.2 per cent gives a total economy of 9.8 per cent. This is the maximum economy obtainable with the heater in Fig. 18 when diverting 15 per cent of the exhaust steam.

The writer refers also to the feedwater heater described in a paper by George M. Basford (Mem.Am.Soc.M.E.) published in THE JOURNAL of The American Society of Mechanical Engineers for September 1917. In that heater the feedwater passes in a thin film between two spirally corrugated copper tubes. The following calculation is presented as a basis of comparison between the heater of Fig. 18 and that described by Mr. Basford.

The value of K or the conductivity of the steel tube as experimented with by Clement and Garland is 48.36 B.t.u. The value of K for copper as given in Marks' handbook is 220 B.t.u. The conductance of the steel tube is 1.204 B.t.u. Using the same thickness for the copper tube as for the steel tube experimented with, the conductance of the former is $(220 \times 1.204)/48.36 = 5.48$ B.t.u. We can combine this conductance with that of the two films as established by Clement and Garland by taking the value shown in Fig. 20 for a water velocity of 15.75 ft. per sec.

It will be observed that the curve for the conductance of the water film is approximately a straight line; while the curve for the combined conductance of tube and film drops away as the velocity of the water through the tube is increased; indicating that the conductance of the metal in the tube is not constant for all velocities.

Reading the values from the diagram, we have:

$$\frac{1}{\dfrac{1}{0.345} - \dfrac{1}{0.505}} = 1.184 \text{ B.t.u.}$$

This gives the conductance of the metal in the tube at the given velocity of the feedwater. Assuming that the conductance of the

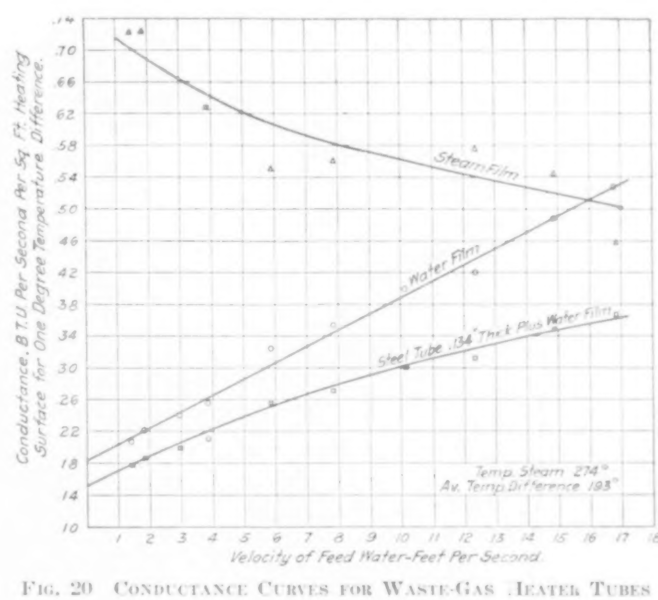


FIG. 20 CONDUCTANCE CURVES FOR WASTE-GAS HEATER TUBES

copper tube will decrease with the velocity in the same ratio, we have as the conductance:

$$\frac{1.184 \times 220}{48.36} = 5.39 \text{ B.t.u.}$$

Combining this conductance with that of the film, we have:

$$\frac{1}{\dfrac{1}{0.505} + \dfrac{1}{5.39} + \dfrac{1}{0.512}} = 0.234 \text{ B.t.u.}$$

The conductance in B.t.u. per sq. ft. of heating surface is then $0.234 \times 3600 = 875$, which agrees very closely with the figure given by Mr. Basford, or 900 B.t.u.

Using the latter figure, we have $900/3600 = 0.25$ B.t.u. conductance; substituting this value in equation above, we have for the heater of Fig. 18 with 30 lin. ft. traverse a final temperature of 178.05 deg. with a thermal content of 145.93 B.t.u. From the

figures given it would seem that the increased efficiency of the heater shown by Mr. Basford is due chiefly to the higher conductance of the metal used.

The foregoing abstract is from the *Railway Engineer*, vol. 92, no. 12, December 1918, pp. 645-649, 8 figs. A continuation of the article is devoted to the following discussion of feedwater heating by waste gases as the heating medium.

Because of the relatively slow absorption of the heat by water from gases, it is necessary in this type of heater to increase the heating surface quite materially over that required for an exhaust-steam heater. This is usually accomplished by employing a large number of tubes of small diameter.

Fig. 21 shows diagrammatically the heater on which the present study is based. It is composed of 320 tubes of 1 in. outside diameter, 6 ft. long, with walls 0.095 in. thick, giving a total heating surface of 407 sq. ft. The tubes are fixed at each end into headers divided into ten compartments each of which contains 32 tubes.

The feedwater enters the lower compartment of one header, flowing thence through the 32 tubes to the opposite header and in this way traversing the heater ten times before passing into the boiler.

The transmission of heat from the waste gases into the feedwater is determined by the author on the basis of the evaporative capacity of a boiler tube under similar conditions.

He finds on the basis of Bulletin 1017 published by the American Locomotive Company that the conductance of the boiler tube is 0.002325/0.523 = 0.00445 B.t.u. per sec. per sq. ft. of heating surface per degree temperature difference.

Further, with data secured by Geo. L. Fowler (Mem.Am.Soc. M.E.) the author determines the velocity of water in ft. per sec. through each pass as being 15.35/7.14 = 2.15 ft.

This is followed by an interesting discussion of the value of the resistance to heat transmission of the film on the gas side, which is of importance, because, apparently, the low heat transmission from gases to water is due mainly, if not solely, to the presence of this gas film.

Reading from Fig. 20 we find at a water velocity of 0.65 ft. per sec., a conductance through the tube and water film of 0.1635 B.t.u. per sec. The conductance of the boiler tube has been found to be 0.00445 B.t.u. As the resistance to heat transfer is the reciprocal of the conductance, we have

$$\frac{1}{\dfrac{1}{0.00445} - \dfrac{1}{0.1635}} = 0.00458 \text{ B.t.u.}$$

or the conductance of the film on the gas side.

In the Clement and Garland experiment, the thickness of the tube walls was 0.134 in., with a conductance through the metal of 1.204 B.t.u. With tubes 0.095 in. thick the conductance of the metal is $1/(6.2 \times 0.095) = 1.697$ B.t.u.

Referring again to Fig. 20, in which the conductance is plotted in relation to the velocity of the feedwater, we find, for a water velocity of 2.15 ft. per sec., a conductance of 0.227 B.t.u. Combining this with the conductance of the tube, we have

$$\frac{1}{\dfrac{1}{1.697} + \dfrac{1}{0.227}} = 0.200 \text{ B.t.u.}$$

or the total conductance of a tube 0.095 thick plus the water film. Carrying this further, knowing the conductance of the gas film, we have

$$\frac{1}{\dfrac{1}{0.200} + \dfrac{1}{0.00458}} = 0.00448 \text{ B.t.u.}$$

or the conductance of the metal, gas and water films.

In this way the total conductance is determined, which makes it possible to compute the quantity of heat transmitted to the feedwater by the heater, and when this is known it is possible to determine the economy of a given heater, which, for the heater shown in Fig. 21 is computed to be 3.4 per cent. This calculation, however, is based on two assumptions: In the first place, it has been assumed that the velocity of the gases through the heater is equal to that through the boiler tubes, and next that a feed pump is employed for forcing the water through the heater, which uses 1.75 per cent of the total amount of steam generated.

The direct economy obtained by feedwater heating with waste gases reduces the unit fuel consumption to 116 lb. and from Fig. 19 it will be seen that the ordinate for a unit fuel consumption of 116 lb. plus the boiler-efficiency curve is 60 per cent, whereas the efficiency at 120 lb. is 50 per cent. Hence the indirect economy equals 1 per cent of the total economy for the waste-gas heater 4.4 per cent.

A further economy may be secured by arranging the heaters in series with the exhaust steam as the primary heating medium and the waste gases as the secondary heating medium, the latter being possible because of the relatively great difference in the temperature of the exhaust steam and smokebox gases. The temperature of the feedwater issuing from an exhaust heater having 30 lineal ft. traverse is 163.3 deg. with the total thermal content of 131.16 B.t.u., as has been previously determined by the author. If this water, after leaving the exhaust-steam heater, be made to traverse the waste-gas heater it will attain a final temperature of 213.65 deg. with the thermal content of 181.65 B.t.u. This increase of

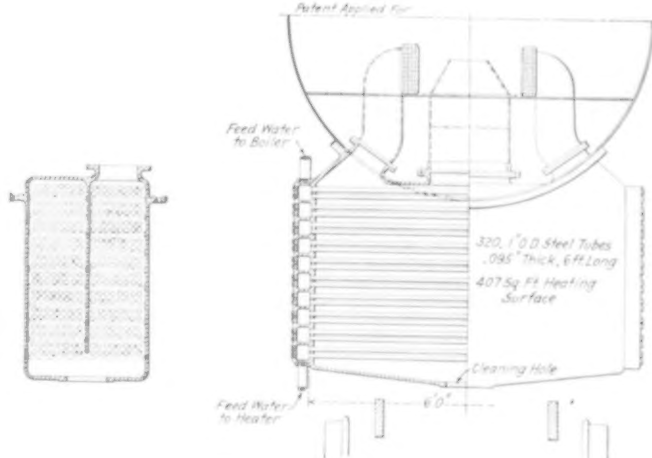


FIG. 21 WASTE-GAS FEEDWATER HEATER

temperature is shown by a curve in the original article. With the degree in temperature head between the waste gases and the feedwater this curve approximates a straight line.

The writer shows that the direct economy by series heating is 11.5 per cent. and the unit fuel consumption is reduced to 106.5 lb. to which corresponds a boiler efficiency of 62.7 per cent or an indirect saving of 3.4 per cent as shown in the diagram of Fig. 19, which, added to the direct economy, gives a total economy of 15.2 per cent.

The following conclusions are given by the writer:

Exhaust steam is superior to waste gases as a heating medium due to the low resistance of the steam film to the transmiss.on of heat.

In a heater using exhaust steam the use of copper tubes is to be preferred to steel or iron on account of their higher conductance. Tubes should have walls as thin as is consistent with strength and wearing qualities.

Exhaust steam may be diverted for heating the feedwater without detriment to the operation of the locomotive if the area of the exhaust nozzle is decreased to give the required draft. This can be done without any increase in back pressure on the pistons.

An exhaust-steam heater such as is shown in Fig. 19, if fitted with copper tubes, will give an economy in fuel of about 11.8 per cent when using 13 per cent of the exhaust steam.

The economy of the heater using waste gases as a heating medium increases nearly in direct proportion to the heating surface. It is very difficult, however, to find space on a locomotive for a heater giving over 5 per cent economy.

High economy may be obtained by using exhaust steam and waste gases in series, but there is not sufficient room on a modern locomotive for such an application.

It is very desirable that further investigation be made of the heat-transmitting property of the gas film.

A summary of the results obtained for various types of heaters as compared with a locomotive not equipped with any but fitted with the ordinary injector is given in Table 5.

In this connection, attention is called to the fact that with the injector while the water enters the boiler at practically the same temperature as with an exhaust steam heater having 30 lineal ft. traverse, there is in the first place (injector) no economic gain, since the heat given up by the steam is equal to the heat given to the feedwater plus the external work done, which really means a loss of approximately 0.7 per cent. (Abstract made by special courtesy of the editors from an advance copy which will appear in the *Railway Mechanical Engineer*, vol. 93, no. 1, January 1919, pp. 44-47, 5 figs., *eA*)

TABLE 5 COMPARATIVE DATA OF LOCOMOTIVE BOILER PERFORMANCE WITH AND WITHOUT FEEDWATER HEATERS

	Without heater	Exhaust-steam heater		Waste-gas heater	Series heaters, waste gas and exhaust steam	
		30 lin. ft.	60 lin. ft.	60 lin. ft.	30 lin. ft.	60 lin. ft.
Boiler pressure	205	205	205	205	205	205
Total heating surface in feedwater heater	....	71.2	142.4	407	478.2	549.4
Unit fuel consumption per hour	120	111.5	107.5	116	106.5	102.3
Average temp., heating medium	....	230	230	600	230-600	230-600
Temp. feedwater entering heater	....	60	60	60	60	60
Temp. feedwater entering boiler injector	163.9	163.3	204.3	120.7	213.65	250.25
Thermal content feedwater entering heater	....	28.08	28.08	28.08	28.08	28.08
Thermal content feedwater entering boiler	131.7	131.16	172.27	88.76	181.65	218.76
Thermal units gained by heating	....	82.60	123.71	40.20	133.09	170.2
Direct economy by heating	....	7.2	10.7	3.4	11.5	14.5
Indirect economy by heating	....	2.6	3.5	1.0	3.7	5.0
Total economy by heating	....	9.8	14.2	4.4	15.2	19.5
Area exhaust nozzle required	38.19	30.2	30.8	30	30.9	31.3
Diameter of exhaust nozzle required	6.97	6.2	6.26	6.18	6.27	6.32

British View of Standardization of Railroad Equipment

Standardization of Railway Equipment. A report of great importance made by the Advisory Council of the Ministry of Reconstruction to the Minister of Reconstruction. It is based on evidence presented to the Advisory Committee by a number of experts and engineers of various companies, as well as memoranda submitted by the British Engineering Standards Association and the Locomotive Manufacturers' Association.

The report recognizes the advantages of standardization of railway equipment where it is possible, as, for example, in India, but claims that conditions in Great Britain are not suitable to its adoption because of the difference in structural and clearing gages and in tunnel dimensions.

In the existing state of things any locomotive designed to run on all the various lines would have to be a compromise and would not be the best possible for each particular railway system. However, so far as the main trunk lines are concerned, the committee is informed that a reasonably efficient engine could generally be designed for use on most of them.

The railway companies have recognized the fact that the development of the design has now reached the stage which allows of standard types being adopted when the conditions on the road are similar and have already begun to introduce standardization in so far as each company is concerned. Thus, the Committee on Locomotive Standardization set up by the Association of Railway Locomotive Engineers have now fixed on two standard engines, with the intention later to design two engines of each type, one heavy and one light, with many of the parts common to all four.

The railway companies, however, in view of the lack of material deprecate the immediate introduction of new types of standard locomotives for which new jigs, patterns and templets are required.

The report points out, however, the existence on British railways of quite unnecessary multiplication of types in certain lines. Thus the evidence before the committee showed that there are 200 different types of axle boxes and that every railroad company had adopted different types of tires, springs and axles. In fact, British railways appear to be severely handicapped by excessive freedom in the adoption of individual fitments, with the result that the working of the railroads is not as economical as it might be.

The report calls attention to the fact that British railways tend to manufacture an unusually large percentage of their supplies, including locomotives, and it is considered necessary from a business point of view to have the cost of production in the railway workshops thoroughly investigated by a competent and independent audit.

The committee also calls attention to the amount of dead weight carried on British railways. The tare of an 8-ton car built to the clearing-house regulations is 70 per cent of the load, as against the 40 to 45 per cent of the other countries.

The following recommendations are also made:

"1 That the standardization of wheels, axles, wheel centers, tires, running gear, draw gear, buffing gear, bogies, brakes and underframes be dealt with immediately by the Engineering Standards Committee, on which all interested, including private builders and makers of materials, should be represented, and that when such essential parts have been standardized the adoption of the standards should be gradually enforced.

"In view of the difficulties of standardizing complete locomotives and other rolling stock under existing circumstances, and of the excessive amount of dead weight now carried on British railways, we recommend:

"2 That a committee be formed to investigate the existing conditions of structural gages and clearances of the British railways, and the loading and unloading arrangements at works and ports, in order to ascertain how far uniformity could be introduced and tares reduced, and at what cost.

"3 That the costs of construction of locomotives and rolling stock by the railway workshops and by private firms respectively be investigated and ascertained by competent independent accountants appointed by the Government.

"In view of the great demand for rolling stock that there will be at the close of the war in this country and elsewhere, we feel that, in order to expedite delivery and to secure production at the lowest possible cost, standardization is very necessary for the export trade. We recommend, therefore:

"4 That the consulting engineers and representatives of railways financed by British capital in foreign parts in the Dominions be brought together to confer with the locomotive and wagon manufacturers in this country to determine what standardization can be effected, and that, with a view to the possibility of effecting partial international standardization, the separate Committees should take cognizance of each other's investigations." (*The Railway Gazette*, vol. 29, no. 21, November 22, 1918, pp. 548-549, *gA*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

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Contributions of interest to the profession are solicited. Communications should be addressed to the Editor.

The Secretary's Letter

PRESIDENT COOLEY'S first address to the members was at Detroit on Saturday night, January 11, on The Unoccupied Rung in the Engineer's Ladder of Fame. Dean Cooley says he spent an entire forenoon on that title! It is needless to say the address was fascinating and "gripped" every one. It was the good fortune of Prof. A. M. Greene, Jr., Chairman of the Research Committee, and the Secretary to be present at that meeting. The two latter were making a short trip to the Sections, visiting Philadelphia, Columbus, Cleveland, Chicago and Indianapolis, to take to the members the account of the work of the Society in research, publications, library, The Engineering Index, and local sections, and in turn to learn what thoughts the members have on these activities.

Notwithstanding that the Society has a large membership, the Secretary hopes he will never fail to give personal attention to the individual member and assist him in his work. The member can always be assured that the Secretary is never "too busy" to see him and never considers a request as undeserving of his personal attention. The Secretary may be engaged at the time a member calls, or away, but in such cases the other members of the staff are equally anxious to serve and, in many cases, are more familiar with the details of the member's particular request.

The spirit of the times is forcing the whole profession to a higher sense of service, consequently the Secretary is getting inspiration from the trip.

Inquiries are made of important leaders in every city as to industrial conditions, and I am happy to report a general optimism. The best-informed men interrogated believed that such depression as we might have would be short-lived and that the cycle from the present conditions down through the depression and on to the upgrade of confidence and return of industrial activity would be completed within the year.

In one of our largest industrial centers plans are already developed for large additions to be put in as soon as weather conditions permit.

Whereas labor is now plentiful and business is what would be called dull, nevertheless there seems to be little idleness and wages are being very gradually reduced. In fact, it would seem to be necessary that all prices have got to come down before much construction can be undertaken. Also the future of the railroads has got to be determined before orders for necessary extensions can be placed.

In Detroit, preliminary but nevertheless quite complete skeleton plans for the Spring Meeting were developed and members are therefore urged to save the date, June 17 to 20, as they will be rewarded with extraordinary opportunities to see the most wonderful industrial plants in the world, as well as to participate in profitable professional sessions and delightful social reunions.

CALVIN W. RICE,
Secretary.

President Cooley's Principles in Making Committee Appointments

PRESIDENT COOLEY spent ten days at the headquarters of the Society in making up his committee appointments, conferring with the Executive Committee and with a number of members who served on committees last year to get their suggestions. The following are the President's own statements of the ideas which were uppermost in his mind in his selection of committeemen:

"In view of the large membership of the Society, I think we can well establish the policy that in general, a man shall serve on only one committee, especially if it is an important and active committee and one which makes considerable demands on his time.

"In an organization such as ours, with members distributed all over the country, it ought to be possible to plan appointments so that members of certain of the committees shall all be within convenient reaching distance of some center, not necessarily New York. For example, a committee might be selected from men who are within easy distance of Chicago and the committee could hold most of its meetings in Chicago. Another committee might center around Boston, another around St. Louis, etc.

"The Society has a large number of committees. Some of these are very active; and some, because of the war or for other reasons, are doing very little. Special war committees, in most cases, can soon be discharged; and committees inactive for other reasons than the war should either be recast or discharged. Thus the number can be kept down and the time of members and also the expense be saved.

"I would like to see more of the younger members of the Society serving on committees. The honor means much to them, and they are usually keen for the work. It is not always convenient for the older men with established businesses to find the necessary time for committee work. Their experience, however, is just what is needed, and they are perfectly splendid in the sacrifices they are willing to make in order to serve the Society.

"Offers from members to serve on committees, or suggestions from members of good committeemen, will at all times be welcomed. A list of available men from which to make selections would be a great help.

"I would also welcome suggestions for changes in the organization of committees. We should be constantly on the lookout for means to improve the work of the Society. Committeemen should not be overburdened. While this cannot always be avoided, the loads can frequently be redistributed by readjustment of the committee organization.

"It will be a great pleasure if I can help in some effective way to keep the government of the Society abreast of the activities of the times. The new Committee on Aims and Organization is making an examination of these activities in the light of present-day developments, and I am sure that as their program unfolds many good sugestions will be forthcoming.

"The responsibilities of the Society increase with its growth, and to meet them the government of the Society must be ever alert and responsive. We must be prompt to adopt new measures when they appear promising, and should not hesitate to discard the old ones when they have become obsolete."

The Cleveland Plan of Engineering Coöperation

LAST WEEK the Council of The American Society of Mechanical Engineers took favorable action upon a procedure of far-reaching importance. In effect, the purpose of the Council is to practically carry forward what has long been well nigh if not indeed a wholly universal desire among technical men for the greater unity of the entire engineering profession. While the present cautious step does not go as far as some enthusiasts may desire, it is nevertheless a decided move in the right direction.

The Council by unanimous vote recorded its willingness to enter an arrangement with the Cleveland Engineering Society whereby joint membership of mechanical engineers, duly qualified according to the respective requirements of the societies, could be effectively fostered between the two organizations. There would be a division of the dues between the two societies, a reduction of $5 being made in the total amount now paid by the active or associate member belonging to both bodies. This sum, though not large enough to be deemed a serious crippling of the receipts when first applied, would, it is confidently believed, be sufficiently attractive to bring into both societies many mechanical engineers who are at present members of but one or perhaps neither of the two bodies.

The plan further contemplates that members of The American Society of Mechanical Engineers may join the Cleveland Engineering Society without the payment of an entrance fee. On the other hand, those who are already members of the Cleveland Engineering Society may join The American Society of Mechanical Engineers—after application and election in the usual and well-known way—by payment of the difference between the entrance fee of the Cleveland Engineering Society and the initiation fee of The American Society of Mechanical Engineers for the particular grade of membership sought. Mechanical engineers not members of either society but applying for joint membership will pay an entrance or initiation fee of $25; $18 of this going to The American Society of Mechanical Engineers and $7 to the Cleveland Engineering Society. Briefly, the foregoing is the tentative proposition adopted in principle by the governing boards of both societies and each is pledged to put it into experimental operation at the earliest practicable date.

For several reasons the plan could not well be given a more auspicious test. Prominent officials of the national societies, and particularly those of The American Society of Mechanical Engineers, have heartily approved of the engineer's being an active force in public affairs, that all technically trained men should unitedly serve the respective communities where they reside, as well as take an earnest helpful interest in national problems. Coöperating as engineers, no matter whether their specialties are mechanical or electrical or civil or mining or metallurgical or of any other field of technical enterprise, they should, as it has often been urged, repay in public service whatever is possible of their educational obligations.

Cleveland offers an excellent opportunity to test out the idea in a very definite and distinctive style. There the local engineering society is very strong in numbers, something over 1200. It maintains all the facilities of a club, is open every weekday, has regular and frequent meetings for all branches of the engineering professions, keeps a critical eye upon all local transactions of consequence to engineers and energetically works in team style with the Cleveland Chamber of Commerce and with other leading civic forces.

One naturally assumes that such a plan may easily lead to other and similar arrangements between national as well as local engineering societies. Certainly the expense in fees and dues does prevent many a young engineer from receiving the benefits of membership in several societies, no matter how well he may be qualified in all other respects. There is also the additional prospect that this plan evolved by the Cleveland engineers may do much toward the institution of similar local bodies elsewhere, and these operating under the above plan with one or more of the national societies of engineers. So promising is the project that we hope for it an abundant measure of success.

R. I. C.

Progress of the Screw Thread Commission

THE Screw Thread Commission, which was appointed by the Secretary of Commerce on September 21, 1919, for a period of six months, is gradually bringing its work to a close. The purpose of the Commission as defined in Section 2 of the Act of Congress which led to the Commission's appointment is "to ascertain and establish standards for screw threads." Necessarily, such an important matter presents problems which must be viewed in an extremely broad manner and originates questions involving alike the user, the manufacturers, the tool and gage maker, those engaged in international and export trade; and to a limited extent the distributor of screw-thread products.

The members of the Commission have considered themselves judiciary in their position and have endeavored impartially to secure the best information possible from all classes of people; from those skilled in the manufacture of screw threads and who have accumulated experience; those experienced in the handling and use of manufactured products; those interested from the academic point, and especially those interested in measurements relating to specifications. These elements are always present and the Commission has endeavored to obtain the best information possible from engineers and manufacturers of these various classes.

The first step in collecting information was to formulate a series of questions thoroughly covering the subject and for this purpose the Commission held three committee meetings in September 1918, two committee meetings and two public meetings for the purpose of hearing testimony during October 1918, six committee meetings and three public meetings for the purpose of hearing testimony during November 1918, and four committee meetings during December 1918. During January 1918 eleven committee meetings were held. On January 20 and 21 the sub-committees on pitches, classification, gaging and terminology prepared their final reports. On the following day the Commission was addressed by F. G. Echols, Chairman, Tap and Die Manufacturers' Association, on Tap Tolerances. The reports of the sub-committees were submitted to the Commission as a whole and adopted by it. The Commission decided that these reports should be correlated and combined into one final report and then submitted to its members. Final reports are to be considered at a meeting of the Commission on February 17 and then made public.

Over 500 communications have been received from manufacturers and engineers who are interested in screw-thread standardization. The Commission, during the taking of testimony in the different cities, was much impressed by the frankness and interest displayed by all concerned, and by the facilities offered for obtaining information. The Commission has accumulated a large amount of information on practice relating to screw bolts of various forms of thread, on machine screws, on threads for hose couplings, brass tubing, and on pipe threads. In addition to this, it has been called upon to decide upon the classification to be provided for and the terminology; questions as to the basis for fit of screw and nut; and tolerances for various forms of fit. A great deal of interest is involved in these questions, in view of the important considerations which arise in relation to the interchangeability of one part with another.

The Commission having heard testimony and collected data covering these matters, is now considering its recommendations which it is hoped to make public early in February; and the public meeting which is to be called is for the purpose of finding whether these recommendations meet the requirements of the industry.

John Fritz Medal Awarded to General Goethals

The John Fritz Medal Board of Award Committee composed of representatives of the Societies of Civil, Mining, Mechanical and Electrical Engineers, held their annual meeting for 1919 at the Engineers' Club, New York, Friday evening, January 17, and awarded their gold medal to Major-General George W. Goethals, the builder of the Panama Canal.

The medal has previously been awarded to John Fritz, of Beth-

lehem, Pa., Lord Kelvin, George Westinghouse, Alexander Graham Bell, Thomas A. Edison, Charles T. Porter, Alfred Noble, Sir William Henry White, Robert W. Hunt, John Edson Sweet, James Douglas, Elihu Thomson, Henry M. Howe and J. Waldo Smith.

Colonel John J. Carty, now in France, has been chairman of the Board, but in his absence Ambrose Swasey, of Cleveland, presided. George H. Pegram has been elected chairman for 1919, and W. F. M. Goss, treasurer, in place of Prof. F. R. Hutton, who died during the year.

A Word About Conditions in England and France

DEAR MR. RICE:

The undersigned, together with Mr. H. L. Aldrich and Mr. A. J. Baldwin, members of the Society on the Technical Editors' trip abroad, constitute what may be called a committee without portfolio, appointed by President Main, to ascertain, if possible, something concerning the flow of engineers from peace-time pursuits into war activities in both England and France, and also to learn what steps had been taken for the return flow of engineers on the cessation of hostilities. Its appointment came in late October as the three of us were leaving the country as guests of the British Government through invitation of the British Ministry of Information to secure facts at first hand of conditions in the British Isles and at the battlefields.

Writing for myself, at least, I will say that the circumstances did not allow for collecting much informing data. As guests our time was very fully occupied in luncheons and dinners and in some plant visitations, with meeting captains of industry and soldiers and public men. We arrived in England only three days before the signing of the armistice, and naturally for the few weeks following the transition from war activities to normal activities was as indefinable as those in this country apparently were.

Volumes of literature had been published during the period of the war, largely under government auspices, looking to covering the problems of readjustment of industry, demobilization and reconstruction, but when the end of fighting actually came, it was clear that no formulæ had been so well perfected that the political or industrial machinery could immediately reverse itself. As we realize, even at this moment, the entire world, neutral as well as warring nations, has not yet recovered from the shock incident to the collapse of the Central Powers.

Just as our own engineering societies were appealed to by governmental agencies for assistance in developing war organizations, so were the officers of the corresponding organizations abroad asked to make nominations and to assist in attracting men to war work, but just as for a time was the case in this country, these war organizations had to be built up with such unprecedented speed that all possible sources of recruiting of engineering talent had to be engaged, and the engineering societies ceased early to be the main, or at least the sole, source of supply.

Very truly yours,

W. W. MACON.

Annual Report of Library Board

THE Library Board of the Engineering Societies Library, which collection embraces the libraries of The American Society of Civil Engineers, The American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the American Institute of Mining Engineers, and is maintained as the joint library of the United Engineering Society, has just issued its annual report for 1918.

The Board for 1918 consisted of:

Edward D. Adams	Richard Khuen, Jr.
B. A. Behrend	Walter M. McFarland
William N. Best	Calvin W. Rice
Harrison W. Craver	Lewis D. Rights
Alfred D. Flinn	Samuel Sheldon
Alex. C. Humphreys	W. J. Slichter
Andrew M. Hunt	Jesse M. Smith
Charles Warren Hunt	E. Gybbon Spilsbury
F. L. Hutchinson	George C. Stone
John H. Janeway	Bradley Stoughton
Samuel T. Wagner	

The total number of visitors during the year was 15,063, an average of 50 daily. In addition to this, over 1500 inquiries were received over the telephone and over 900 letters asking for information were answered.

The total number of searches made was 508. Work was done for almost every technical bureau of the Government, for the Naval Consulting Board, the National Research Council, for many firms manufacturing material and supplies for the Government, and for many of the Allied nations and their representatives.

Seventy-eight translations were made, as against 59 for 1917. Orders for photographic copies, 1150 in number, called for 6306 prints. In 1917, 791 orders for 1342 prints were received. This increase is partly due to wider knowledge of the Library's ability to supply copies in this way, and partly to the indexes in the monthly publications of three Founder Societies, which create a demand for copies of the articles indexed.

During the latter half of the year the Service Bureau of the Library has compiled a monthly index to mining and metallurgical literature, for the American Institute of Mining Engineers. This index the Institute publishes in its Bulletin.

The total number of accessions during the year amounted to 16,921, making the collection total, on December 31, 1918, 157,795 volumes and pamphlets, there being 38,975 of the latter.

A number of unavoidable causes have made it impossible to catalog all the accessions of the year, but the books of greatest importance and those most in demand have been given the preference, and have all been cared for. The remainder of the available time has been spent in revising those portions of the catalog which gave most trouble in daily use.

The number of volumes obtained as gifts during 1918 was unexpectedly large. The largest single gift, comprising about 8000 volumes and pamphlets, was a library of electrical literature presented jointly by the Westinghouse Electric & Manufacturing Company and the General Electric Company. This library, formerly the property of the joint Board of Patent Control established by these companies, includes sets of the most important electrical journals, a comprehensive collection of patents relating to electric power and transmission, and a unique series of records of adjudicated patent cases in that field.

Most of the new books issued by American publishers are received by the Library for review purposes, so that purchases of current volumes have been confined for the greater part to works published abroad.

The Library has also been the frequent recipient of gifts from many individuals and firms. Among the more noteworthy of these gifts are a collection of 370 pieces presented by Mr. Jesse M. Smith, containing interesting data on various patent litigations, and a collection of books on gas engineering, presented to the American Gas Institute by Dr. William Paul Gerhard, and transferred to the Library by that society, with his approval. Mr. Clemens Herschel presented a collection of bound pamphlets and papers published by him at various times, forming with those already in the Library, practically a complete collection of his contributions to engineering.

Three Founder Societies are now publishing indexes, viz.: The American Society of Civil Engineers, the American Institute of Mining Engineers and The American Society of Mechanical Engineers. The first and last of these are compiled by the respective societies, the remaining one by the Service Bureau. A committee is now considering the possibility of consolidating the preparation of two or more of these, under the direction of the Library. Such a consolidation of effort would permit the field to be covered more carefully without increased expense, would tend to standardize the methods used and would form an important step toward the realization of a complete, permanently established index.

Council Notes

A MEETING of the Council was held in the rooms of the Society on Friday, January 17, 1919. There were present: M. E. Cooley, *President*, in the chair, H. B. Sargent, F. O. Wells, Spencer Miller, F. R. Low, R. H. Fernald, C. L. Newcomb, John A. Stevens, Chas. Russ Richards, D. Robert Yarnall, John Hunter, Ira N. Hollis, John A. Brashear, Ambrose Swasey, Wm. H. Wiley, *Treasurer*, Geo. A. Orrok, *Chairman Publication Committee*, S. D. Collett, *Chairman Membership Committee*, W. E. Symons, *Chairman Finance Committee*, Calvin W. Rice, *Secretary*, and, by invitation, E. S. Carman, R. I. Clegg and J. H. Herron, of the Cleveland Local Section.

Special Orders

Joint Membership. Messrs. Carman, Clegg and Herron, members of the Cleveland Local Section, presented a proposed plan of joint membership in the Cleveland Engineering Society and this Society, with combination initiation fees and dues. After discussion in which practically all the members present participated, the following resolutions were passed:

Be It Resolved: That the Council of The American Society of Mechanical Engineers approve in principle the coöperative plan of affiliation of the Cleveland Local Section with the Cleveland Engineering Society as presented to the Council January 17, 1919, by the three Am. Soc. M. E. delegates from Cleveland, invited by the December Council.

Be It Further Resolved: That the matter be referred to the Committee on Local Sections and that this Committee be directed to prepare and propose an amendment to the Committee on Constitution and By-Laws for the general plan for such affiliation to all sections.

Be It Further Resolved: That the Committee on Local Sections be granted a special appropriation for one year's trial of the proposed plan, if in the opinion of the legal counsel of the Society such action can be taken without violating the Constitution and By-Laws of the Society.

Executive Committee

The President announced the constitution of the Executive Committee as follows: M. E. Cooley, *President, Chairman ex officio,* Chas. T. Main, Ira N. Hollis, John Hunter, D. S. Jacobus, Henry B. Sargent.

Standing Committees of Administration

Finance Committee. The President announced the appointment of Alexander Dow to serve for five years and reported the election of W. E. Symons as *Chairman* of the Committee.

Meetings and Program Committee. The date of the Spring Meeting in Detroit was approved. The meeting will be held June 17-20, 1919.

Wm. A. Viall, *Chairman,* F. H. Colvin, A. J. Gifford, J. N. Heald were approved on the Sub-Committee on Machine Shop Practice.

Publication and Papers Committee. The President announced the reappointment of Geo. A. Orrok.

Membership Committee. The President announced the reappointment of Hosea Webster.

Constitution and By-Laws Committee. The President announced the reappointment of James E. Sague.

Local Sections Committee. The President announced the appointment of Sumner B. Ely.

Mr. Yarnall presented a petition from the members of the Society in Washington, D. C., for the formation of a Local Section, which was approved.

The Secretary gave an oral report of his visit to the mid-western Sections during the month of January, on which he had been accompanied by Prof. A. M. Greene, Jr., *Chairman* of the Research Committee, who had presented the plans of the Research Committee.

Standing Committees

Library Committee. The President announced the reappointment of Jesse M. Smith. The annual report of the Library Board of the United Engineering Societies was received.

Research Committee. The President announced the reappointment of R. J. S. Pigott.

Standardization Committee. The President announced the appointment of W. S. Twining.

Professional Committees

Boiler Code Committee. Interpretations covering cases Nos. 205-207 of the Boiler Code were approved.

Special Committees

Industrial Relations. The President announced the appointment of the following Committee on Industrial Relations to give preliminary study to

a The advisability of establishing a permanent committee on relations between employer and employee;

b The best method of encouraging our membership to fulfill their high duty in that field for which their training and activities should fit them:

A. W. Burchard, *Chairman*	
J. W. Lieb	H. D. Sharpe
M. W. Alexander	Chas. Cheney
Frank A. Scott	W. H. Manss

Student Branches. The President announced the appointment of Ira N. Hollis as *Acting Chairman.*

Appointments by the President

Tellers of Election. J. H. Lawrence, *Chairman,* Mancius Hutton, R. K. MacMaster.

American Association for the Advancement of Science. John A. Brashear and W. B. Gregory.

Engineering Institute of Canada. Annual meeting in February of the Engineering Institute of Canada, Dr. Ira N. Hollis, Past-President.

Washington Award, Western Society of Engineers. Chas. F. Brush.

Welding Committee, U. S. Shipping Board. F. L. Fairbanks. The report from Mr. Fairbanks recommending that the Society be represented in the new association of this committee to continue its work in research, was received.

U. S. Bureau of Standards. Wm. A. Viall, J. W. Upp and C. M. Hansen, as Honorary Vice-Presidents to represent the Society at a recent conference called in Washington on the subject of standardization of industrial safety codes.

Appointments by Council

Engineering Foundation. The term of service of W. F. M. Goss was changed to three years to comply with the by-laws of the United Engineering Society.

National Rivers and Harbors Congress. Wm. H. Wiley, Honorary Vice-President to represent the Society at the National Rivers and Harbors Congress, Washington, D. C., February 5 to 7.

Adjournment was taken to meet Friday, February 21, at a place and hour to be determined by the President.

Calvin W. Rice,
Secretary.

An elaborate report has been issued by the Board of Public Works of Detroit, Mich., on the proposed bridge to connect Belle Isle, the beautiful park and playground of Detroit, with the city to facilitate transportation to and from Belle Isle. This report contains many diagrams and illustrations. It was prepared by a consulting board appointed for the purpose, of which M. E. Cooley, President of the Society for the current year, is chairman.

Government Action on Recommendations of Committee on Standardization of Gages

THE following letter received by the Chairman of the Society's Committee on Standardization of Gages from the Director of the Bureau of Standards sets forth in interesting detail the extent to which the recommendations of the committee have been carried out by the different departments of the Government in coöperation with the Bureau, particulars of the amount of work accomplished, and opinions regarding the prospect of a continuation of the Bureau's activities in this direction which would be of great benefit to American industry during the reconstruction period and the ensuing peace conditions. A full statement of the work of this Committee and its recommendations to the Government departments appeared in The Journal of January 1918, on page 70.

Dear Sir:

I have to reply herewith to your letter of December 28 requesting answers to six questions concerning the outcome of the recommendations of the Committee on Gages and Standards of The American Society of Mechanical Engineers.

The answers to your question are given below:

1 *How far have the recommendations been carried out by different Government Departments in coöperation with the Bureau of Standards?*

In reply to question No. 1, we have to advise as follows:

a The Ordnance Department has submitted practically all their master gages and also a considerable number of inspection gages for test at the Bureau of Standards in Washington. The Ordnance Department has further coöperated with the Bureau of Standards in making it a central point for the storage and dispatch of master gages. With this arrangement the shipment of gages to Army Inspectors of Ordnance at manufacturing plants having Government munitions contracts, has been greatly facilitated. In addition there has been organized at the Bureau of Standards a gage shop for the salvage and manufacture of master gages and inspection gages needed for exigency purposes. Up to the signing of the armistice this Gage Shop employed from 60 to 75 toolmakers and the equipment available included a complete tool shop equipment, such as precision lathes, grinding machinery for plain gages, thread grinders, and other shop accessories. In all about 60 machine tools were in use in this shop. With gages stored and with a salvage shop available at the Bureau, it was possible to supply sets of master gages revised to the latest component drawings, where otherwise it would have been necessary to send out gages which had become obsolete during the course of their manufacture. This Gage Shop was also used to very good advantage in the way of supplying inspection gages needed to prevent stoppage of production. Gages for this class of work were manufactured in anywhere from 3 days' to 2 weeks' time, whereas it would have taken several months to secure the gages in the ordinary procedure of securing bids and placing a formal order with gage manufacturers. An instance is mentioned in which this Bureau supplied 6 gages required for immediate use overseas within 4 days, whereas the best delivery obtainable from any Government arsenal or gage manufacturer was 2 weeks. The gages in question were immediately dispatched overseas by carrier.

The Gage Shop at the Bureau of Standards has also supplied various arsenals and district offices with gage-measuring apparatus, especially lead-testing machines. Further coöperation with the Ordnance Department has taken place in the development of an invention covering the manufacture of precision size blocks similar to the Swedish gages. This work has progressed to the extent of completing about 500 gages which are accurate for flatness, parallelism and size within 0.000005 in. It is expected that about 50 sets of gages will be completed about March 1.

b The Motor Transport Division, Quartermaster Department, have submitted for test and certification practically all of their master product parts and master gages. These gages have been stored at the Bureau and dispatched as required directly to manufacturers executing Government contracts for motor trucks and motor truck parts.

c The branch of the Signal Corps which was afterwards organized at the Bureau of Aircraft Production submitted a number of master gages and inspection gages for test at the Bureau of Standards at Washington before they had any inspection facilities of their own. However, practically no gages have been submitted from this branch since January 1, 1918 as the Bureau of Aircraft Production established a gage-testing laboratory in New York in collaboration with the British Ministry of Munitions in United States.

d The Navy Department has coöperated with the Bureau of Standards to the extent of investigating the methods used for measuring gages at the Bureau and in securing technical advice and information on their gaging problems. The Bureau of Standards was asked to calibrate the measuring machine at the Naval Gun Factory at Washington, D. C. The measuring machine referred to is the standard to which all naval guns are manufactured. Practically no gages have been submitted for actual measurement by the Navy Department.

2 *To what extent has the Bureau of Standards responded to the demand made by such departments?*

a Preparations were made by the Bureau of Standards at an early date to handle promptly the test of all munitions which might be submitted by various Government departments. On June 15, 1917, a special war appropriation of $150,000 for gage standardization by the Bureau of Standards was approved by Congress; and on July 8, 1917, apparatus and equipment was transferred to a special building for the testing of munition gages. The first lot of munition gages was submitted on June 16, 1917.

b During the months of June, July, August and September the Gage Laboratory was overorganized, there being more inspectors available than were required for the test of gages delivered during this period. The personnel and equipment was increased as rapidly as was consistent with information which could be obtained from time to time regarding the number of gages likely to be submitted for test from various sources. It was surprising, indeed, to learn of the organization of a separate gage laboratory by the Bureau of Aircraft Production in spite of the fact that the facilities available at this Bureau had been repeatedly called to the attention of responsible officials in charge of aircraft work, especially as the Bureau of Standards had rendered very prompt service in the test of gages submitted by the Signal Corps before they had facilities of their own. In this connection an instance will be cited where a lot of 110 thread gages were submitted on Saturday noon, were tested and delivered with a complete report to the Signal Corps Inspector on Sunday night, the Inspection force being on duty during Saturday afternoon holiday, Saturday evening and on part time the following Sunday.

c Particular pains have been taken to supply information on gages tested to all interested parties. In all lots of gages tested, 8 copies of the report showing the acceptance, rejection or measured dimensions of the gages had been written and in many cases, it has been necessary to make from 11 to 12 copies of these reports. For instance, on gages tested for the Ordnance Department, copies of the reports had been supplied to the gage manufacturer, the contractor using the gages, 2 copies to the Inspection Division, one copy to the Procurement Division, one copy to the Production Division, one copy to the Engineering Division, and one copy to the property officer.

3 *How many gages have been certified for each department? What per cent of rejections?*

a An idea of the amount of work which has been submitted at the Gage Laboratory in Washington is given in the following table which indicates the number of gages which have been received, tested, certified, or rejected:

1917	July	244	1918	May	4917
	August	473		June	5559
	September	456		July	4720
	October	737		August	4106
	November	1735		September	3207
	December	1142		October	3450
1918	January	2519		November	3270
	February	1813		December	1620
	March	3582			
	April	4688		Total	48238

In the above table about 60 per cent could be classed as plain gages (plain, plug, snap, and ring gages); about 20 per cent as profile gages (complicated templets, chamber gages and fixture gages); and about 20 per cent thread gages. Of these gages about 70 per cent were on account of the Army Ordnance Department; 10 per cent were on account of the Motor Transport Division, U. S. Army; about 5 per cent were on account of the Signal Corps; and the remaining 15 per cent were on account of other branches of the Federal Government and industrial concerns having Government contracts. In addition to the foregoing testing, the Bureau has been called upon to inspect gages used in the production of cannon at various points in the field. In this connection over 300 gages were inspected for the 75-mm. field gun at Rochester, N. Y.; and over 600 gages for the 3-in. anti-aircraft gun were inspected at Philadelphia.

b The following table shows the gages received at the various branch laboratories:

		New York	Cleveland	Bridgeport
1918	April	241	....	....
	May	459	....	....
	June	431	....	....
	July	737	276	....
	August	1434	409	48
	September	1225	424	458
	October	1541	360	462
	November	1843	430	441
	December	1665	479	454
	Total	9576	2378	1863

c With reference to the percentage of acceptance and rejection of gages the following figures taken from the test for the Ordnance Department are submitted:

Approved	70 per cent
Rejected	17 per cent
Measurement dimensions reported	13 per cent

4 *How many branches have been inaugurated and where?*

Branch Gage Sections have been inaugurated as rapidly as the need could be determined. The Branch Gage Section in New York

City was opened April 15, 1918 and includes at the present time a complete gage testing equipment with about 25 persons. The Branch Gage Section at Cleveland was opened July 1, 1918 and includes a complete gage testing equipment and, until recently, a personnel of 6 to 8 persons. The Bridgeport Branch Gage Section was opened August 20, 1918, at the request of the Ordnance Department. There is available in this branch a complete gage testing equipment and a working force of 6 people. Both the New York Branch and Cleveland Branch were initiated by this Bureau and have been well supported and fulfilled an apparent need. These Branch Laboratories were organized mainly for the purpose of taking care of the test of gages needed for exigency purposes, such as inspection gages and working gages being secured by Government contractors and needed for the maintenance of production. The inspection of master gages ordered by Government departments has been taken care of in practically all cases at the Laboratory in Washington in order that the Branch Laboratories would not be congested with this work and thereby interfere their functioning.

5 *How fast has the Bureau been able to handle certification? What periods of delay have there been, and if any delay, what were the contributory causes?*

Every effort has been made to render prompt service in the test of gages submitted. In many cases where gages were urgently needed, gages have been received, tested and the report mailed on the same day. The average time of test for the gages submitted at the Bureau of Standards and Branch Laboratories has been 3½ days. In some cases, particularly large shipments of gages have been held for test for a period of about 2 weeks but the delays in this case have most all been due to the fact that drawings were not available for the examination of the gages, and very often gages have been submitted without definite shipping instructions as to their disposal, or with information lacking as to the source of the gages or nature of the test required.

6 *During the reconstruction period and during peace conditions following, what prospect is there of having the Bureau of Standards and its branches continue in this work so as to be a continual benefit to American industry?*

The Bureau of Standards which is a branch of the Department of Commerce is a permanent institution organized for the development, construction, maintenance and custody of standards of measurements, performance and practice. There is no reason why the facilities in a way of gage testing and scientific staff, made available by war conditions, should not be continued to a large extent for the benefit to American industry during the reconstruction period and indefinitely thereafter. In the work of test and certification of gages during the war, an immense amount of data and information has been accumulated, which the Bureau intends to make available to manufacturers in the way of publications, magazine articles and technical papers.

b It is believed that manufactures have, in the execution of Government contracts, come to realize the advantages of interchangeable manufacture where production is large and that the demand for gages and measuring tools will exceed many times the demands for this material before the war.

c Up to this time the energy of the Gage Section of the Bureau of Standards has been devoted mainly to the test and certification of gages. However, it is planned to use the technical staff for the collection of information and data on the practical problems of manufacturers; for the carrying out of experiments and investigations on such problems as the design, manufacture and application of gages; and for research work in the development of new formulas, charts, methods of test, and for the organization of simple and effective pieces of apparatus for general shop use. The Gage Shop at the Bureau of Standards should be maintained for the construction of precision shop reference standards, including end measures, thread gages, various sizes of standard gages decided upon by the National Screw Thread Commission, and other forms of measuring standards. Furthermore, this shop will be of excellent service in connection with the development of new and simplified forms of shop measuring tools and apparatus, and for the test and development of special machinery for producing gages such as thread grinding machines and the like.

d It is planned to continue indefinitely the operation of the Branch Gage Section in the United Engineering Societies Building at New York City and the Branch Gage Section in the Plymouth Building in Cleveland, Ohio. Service for the testing of gages will be available in these Branch Laboratories and in the Laboratory at Washington for the testing and certification of gages submitted by manufacturers upon payment of a nominal fee. With reference to the matter of charging fees for the test of gages, it is a policy of this Bureau to make charges in case the work done is of direct benefit to one or two interested parties. However, when investigations or experiments are conducted, the result will be of general utility to manufacturers, no fee is charged. The continuation of the New York Branch and the Cleveland Branch will also serve as Headquarters for the technical staff in the field, where the application and operation of the various methods and pieces of apparatus devised and utilized by the Bureau of Standards can be explained to representatives of manufacturing concerns. These laboratories will also serve as points with which manufacturers can get in touch with the Bureau of Standards an technical problems arising in their work.

The possibilities in the utilization of the technical staff and facilities available at the Bureau of Standards in Washington, New York City and Cleveland will depend largely upon the demands made by manufacturers and by the general support given to these projects. An appropriation of $150,000 has been requested of Congress for the operation of the Gage Section for the fiscal year ending June 30, 1920, and the work of the Gage Section for the coming fiscal year will depend, of course, upon whether or not this appropriation is made available.

If additional information is desired by your Committee, I would be pleased to have prepared such articles or information as you require. It occurs to me that it might be well for your Committee to transmit part or all of the material presented in this letter to the technical press for publication, and I would like to know if such action is taken.

Respectfully,
(signed) S. W. STRATTON,
Director.

Washington, D. C.,
January 3, 1919.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A. S. M. E.

Research! What Will You Do?

THE Research Committee of the A.S.M.E. has decided to inaugurate several activities and asks the assistance of the membership of the Society in this work.

The research of the last four years in the countries of our Allies and at home has been able to circumvent the hellish devices of the Hun. The work of the layman, the pure scientist and the engineer has developed methods of detection, method of manufacture, processes and devices which were never thought of before. Many have started the solution of special problems which by a further extension may be made general. Some have started problems which have been discontinued now that the active fighting has ceased, and these by a little more work could become of great value.

In many laboratories of our technical schools and universities and of our large industries and of our private investigators there have been research problems worked out which have never been published for one reason or another, and these would be of great value to the profession if announced.

The equipment of some laboratories is especially fitted for a definite kind of research, and if this were known, problems of the nature fitted for the equipment would come naturally to these laboratories, while other problems would go to other laboratories. The knowledge of the equipment is therefore of prime importance. For this reason a survey of laboratory facilities of the whole country should be made.

Many problems are arising each day for which research information is needed. This information is required by those who have equipment and staffs for research, and for such the Research Committee cannot do much, but there are many engineers and manufacturers who are not in a position to undertake the investigation because they lack investigators and apparatus. The problems of such persons should be stated so that those prepared to undertake them can be brought in contact with those who need the data from the investigation.

These are the conditions at present, and to meet them the Research Committee has made the following plans:

1 *Research in Progress.* The Committee desires the members of the Society, the manufacturers who maintain laboratories, the directors of private laboratories and college laboratories and the directors of experiment stations to report to the Committee the research problems on which work is being done. The subjects of these investigations will then be published in MECHANICAL ENGINEERING. The Committee will give case numbers to these investigations and cross-reference them on a card index. In this way it is hoped that the profession will know what work is being done and where these investigations are being made.

2 *Results of Research.* The Committee desires that results of investigations be sent to them for publication in Mechanical Engineering, The Journal of The American Society of Mechanical Engineers. If the investigation is best presented in an article, it will be advisable to so give it. The Committee believes that there are many investigations of a restricted nature which, while not warranting a paper, should be reported in a concise statement of results, with curves or tables, and it is the wish of the Committee that our members coöperate in sending in this information. These results will be numbered in some way for reference so that one may be able to obtain the information rapidly.

3 *Problems to Be Solved.* It is asked by the Committee that those having research problems on which they desire information and on which it is possible to publish the problem will communicate the problem, and this will be properly presented in Mechanical Engineering with a case number. This will bring to the attention of those properly equipped problems on which they may work, and will bring together the person desiring research information and the laboratory equipped by staff and apparatus to do the work.

4 *Laboratory Equipment.* The Committee hopes to publish from time to time statements of the laboratory facilities of various individuals, corporations, colleges and experiment stations so that it may give to the profession a clear idea of the facilities within the various districts of our country. This it hopes will stimulate work and aid those who have problems to place them at a near-by point.

5 *Bibliography.* For those starting research, bibliographies will be prepared by the Society if the scope of the investigation is such that the Council of the A.S.M.E., on recommendation of the Research Committee, approves. On approval by the Committee the request will be made of the Council and the bibliography prepared. A copy of this will be loaned to the person beginning the research for a proper period, and at the same time a notice of the bibliography will appear in Mechanical Engineering, so that any others interested may borrow the carbon copies of the bibliography for a period of two weeks. In this way three or four carbon copies may be made of great value. The original and the carbon copies will be filed for reference in the Library of the United Engineering Societies. The bibliographies will be made from the excellent library of the U. E. S., one of the best technical libraries in the world.

These points are the initial steps in the present plans of your Research Committee. To make them successful you are asked to help. Coöperation and a united front have been successful in winning the war; they have been successful in industry and in trade. The Committee needs the help of each one, and for that purpose it hopes that you will aid in sending in data under any of the four heads. The Committee cannot know the work under way, the results, the equipment or the problems unless you send them the information. The success of this depends on each individual member, on you! Will you help?

Arthur M. Greene, Jr., *Chairman,*
Research Committee.

NEWS OF OTHER SOCIETIES

American Institute of Electrical Engineers

At a meeting of the American Institute of Electrical Engineers held on January 10 in the Engineering Societies Building, New York, Major-General George O. Squier, Chief Signal Officer of the U. S. Army, gave for the first time the history of the achievements of the country in aviation during the war. The address, which was upwards of 30,000 words in length, was given at the direction of the Secretary of War.

General Squier said that 8600 aviators had been trained in this country when the armistice was signed, while in the production of airplanes, 350 firms, employing 200,000 men and women, were engaged. Through this organization it was possible, he said, to produce 14,000 Liberty motors with an equivalent of 5,700,000 horsepower up to November 11. At this date the Army had adopted four airplane types on which production was to have started in the calendar year.

One of the striking accomplishments was the development by the Navy of the naval seaplane or flying boat NC-1. This plane has a wing span of 2400 sq. ft., is equipped with three Liberty engines with tractor screws, and when fully loaded weighs 22,000 lb. It is the largest seaplane in the world and on a recent test made a trip from Hampton, Va., to Rockaway Beach, N. Y., carrying fifty-one passengers. The fifty-first passenger, it is interesting to note, was a stowaway.

After telling how the problems of obtaining spruce, linen, and castor beans were met, General Squier declared that behind the production figures of November 11 there was mobilized in the United States an industrial army of about 350 concerns and corporations employing more than 200,000 men and women.

The Science and Research Division of the Signal Corps at the time of the beginning of the armistice had in progress sixty-four problems, he said. Among the work completed was the designing and development of a new and improved venturi-pitot tube for the use in the determination of air speed.

The satisfactory progress made with the vacuum tube has resulted in a new type of military unit known as a voice-commanded squadron, which is directed by the commander in any manner desired by voice, thus enormously increasing the squadron's efficiency as a military machine.

Aviation in the Future

"If America will but press on into the future, building upon the sound foundations now erected," continued General Squier, "she may lead the world in the development and utilization of aerial navigation for the triumphs of peace.

"By a wise policy of readjustment, utilizing immediately our machines and our surplus aviators for the rapid expansion of the aerial mail and special passenger services, it will be possible to salvage a greater percentage of the money and energy invested for strictly war purposes than for any other feature of our war activities."

Transcontinental and transatlantic flights in dirigibles soon will be a commonplace occurrence, through the more extensive use of helium, a non-inflammable gas.

Now, through the efforts of the Navy Department and the Bureau of Mines, more than 147,000 cu. ft. of helium was ready for use, with plants under construction which would be able to turn out at least 50,000 cu. ft. daily at a cost of not more than ten cents a cu. ft.

Greater safety in transcontinental and transatlantic flights will be made possible through the establishment of upper air stations by means of balloons. By this means air currents can be forecast and accurately gaged. Recent experiments have shown that above the level of 10,000 ft. 95 per cent of the winds, both in the United States and Europe, are from west to east, and often attain a velocity of 100 miles an hour. November 6, at Chattanooga, Tenn., a velocity of 154 miles an hour was discovered at an altitude of 28,000 ft. Preparations are now under way to make similar observations from ships on the sea along the proposed transatlantic route.

American Society of Civil Engineers

The 66th annual meeting of the American Society of Civil Engineers was held January 15 and 16, in the Engineering Societies Building.

As a rule at the annual meetings of the American Society of Civil Engineers only business matters are transacted and addresses of a general nature presented, but not strictly technical papers. This meeting was no exception in this respect.

Mr. Fayette Samuel Curtis, of Boston, was elected president of the society for the coming year.

A subject which evoked considerable interest and resulted in a formal unanimously adopted resolution was the matter of the summary dismissal of about 350 engineer employees of the Public Service Commission for the First District of the State of New York. The Brooklyn Engineers' Club presented to the Board of Directors a series of resolutions which vigorously protested against this act, as being both unfair to the men deprived of their jobs and liable to cripple the engineering activities of the Public Service Commission, which at the present time has on its hands the important work dealing with the construction of the great transportation system of New York City.

This matter is already under consideration by the Engineering Council, and the American Society of Civil Engineers went on record as endorsing the resolutions of the Brooklyn Engineers' Club.

Another matter of interest to the entire engineering profession was brought up before the Society in the resolution offered by R. S. Buck. In this case the society went on record as favoring a policy by which the Government would undertake at the present time extensive public works so as to reduce, or, if possible, entirely prevent the unemployment threatening this country during the transition of the industries from the war basis to the peace basis.

Brig.-Gen. R. C. Marshall, Jr., presented an extensive address dealing with the many difficulties involved in the construction of cantonments and the organization which permitted having this vast work carried out in the comparatively brief space of 90 days under war conditions. In the course of this address General Marshall stated that the experience of the War Department has shown that if it had to deal with one great united engineering society representing the entire profession instead of as at present with 19 independent organizations, the task of the War Department would have been materially lightened in several ways.

HELIUM FROM NATURAL GAS

(Continued from page 158)

recounting his experiences and discussing the general theory of the subject, is intensely interesting.

By use of an expansion engine, Claude was able to drop the initial gas pressure to from 400 to 600 lb. per sq. in., or even lower in some of the larger units recently erected for air separation. At these pressures the effect depended upon by the Linde system practically disappears so that, in practice, the Claude system works essentially on a wholly new principle rather than by the superposition of this upon that of the Linde process.

However, as Claude confined himself to one expansion engine,[1] it was necessary for him, with his moderate initial pressure, to locate the engine's gas intake at a level in his interchanger sufficiently low so that the exhaust would reach the lowest temperature desired in the system and still be able to absorb quite an appreciable amount of heat at this temperature.

With the one engine taking its gas from the incoming side of the U, it is also evident that for efficient liquefaction only a part of the gas can be expanded through the engine, for, if liquefaction takes place in its cylinders, expansion to that extent is lost. The remainder of the gas must, therefore, be retained under pressure in the U and cooled down and liquefied by heat exchange with the expanded gas returning as indicated by the spiral line around both legs of the U. The gas after liquefaction in leg A is let into leg D through the throttle and there under the lower pressure rapidly drops still further in temperature by its own evaporation. Here it undergoes fractional distillation as already explained above.

Jefferies-Norton System

Coming finally to the Jefferies-Norton system, Fig. 6, it will be noted that this differs from the Claude in at least three important points, viz.:

1 The system employs more than one engine (in the illustration three AE, BE and CE), each working through a different temperature range. The number of these temperature steps depends upon conditions, increasing with the total range of temperature to be covered and also with decreasing initial pressure employed.

2 The pressure in the outgoing leg of the U is only enough lower than in the incoming leg to allow for proper control of flow, unavoidable friction, head of liquid in the still trays and the like.

3 The engines work upon the gases after their liquefaction and distillation, thus permitting all the gas to be so treated. Incidentally, this also insures freedom from easily frozen impurities entering the engine valve chambers and cylinders and in many cases greatly simplifies the whole problem of initial purification of the gas to be treated. Engine C corresponds in a way to Claude's one-engine system but as the initial pressure used in the system can, on account of its greater efficiency, be much less than the Claude, the temperature range over which this engine works will be much less than in the former. Since, when expanding a given weight of gas between two definite pressures, the work obtainable from it (and consequently the number of calories its expansion will extract from the system) is greater the higher its temperature, engine A will extract the most heat from the system and deliver the most power to the crankshaft per unit of gas used and engine C the least, which still further emphasizes the importance of this development.

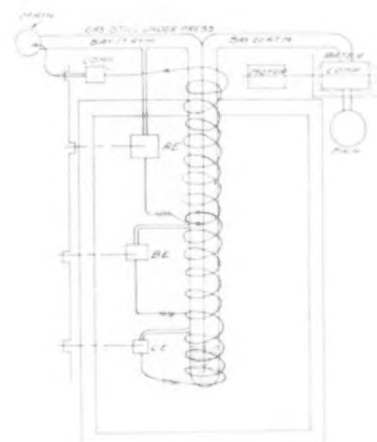


Fig. 6 Jefferies-Norton System

Rough analogies, though suggestive, are often dangerous to accuracy in scientific and technical explanations but without laying any great stress upon it, the following may here be helpful to those not especially familiar with this subject. It was pointed out at the start that a considerable amount of the refrigerative effort which has to be expended in any of these processes is to remove the heat which, despite the best insulation we can put on the apparatus, still leaks in from without. Now in this sense the expansion engines of the last two processes may be thought of as engaged partly in pumping out this heat from the refrigerated system back to the outside, much as mine pumps are kept busy pumping out the water which leaks into a mine. Just as water may be coming in at various levels in the mine so heat is leaking into parts of the system at all levels of temperature. The one engine of the Claude system is analogous to the mine with a single pumping station at the very bottom where all water entering at any part of the mine is allowed to drain clear to the bottom and is then all pumped from there to the surface, while the Jefferies-Norton system is analogous to the installation of several pumping stations at different levels so that water from the upper levels is pumped out over the shorter lifts, thus saving power.

The really salient feature brought out in these diagrams is perhaps the progressive approach toward the ideal of thermodynamic reversibility and the high degree to which this is fulfilled in the basic principles of the last system. There are many other interesting and important features both in the theoretical aspect of the cycle employed and in the details of mechanical construction of the plant at Petrolia which might be given if space permitted, but I fear I am already overstepping reasonable bounds in this particular.

[1] Though this is in many cases compound, having a high- and a low-pressure cylinder.

AMONG THE LOCAL SECTIONS

The Secretary and the Chairman of the Society's Committee on Research, Prof. Arthur M. Greene, Jr., head of the Mechanical Engineering Department of Rensselaer Polytechnic Institute, have been attending meetings of the Sections and telling of the work of the Society, but more particularly, learning of the wishes of the members. As expressed in the notice sent out for the Chicago Section meeting, "C. W., otherwise known as Calvin W. Rice, will be there, and he wants us all to tell him how to run the Society."

This is the spirit of the visits to Philadelphia, Columbus, Cleveland, Detroit, Chicago, University of Illinois and Indianapolis.

At Detroit, President Cooley gave the principal talk on The Unoccupied Rung in the Engineers' Ladder of Fame.

Splendid interest was displayed in each place, showing that with the prospects of peace one may once more devote his thought to professional and society work.

Further, it was characteristic of many gatherings that men met who had never before known each other, thus directly promoting the feeling of brotherhood which is so essential and one of the principal objects of the Sections.

The Secretary will continue to go out among the Sections, going southeast in February and northeast and southwest in March.

ANNUAL MEETING CONFERENCE OF SECTIONS' DELEGATES

New York, December 4, 1918

Extracts from Reports Rendered by the Delegates

Atlanta, Robert Gregg, *Chairman:* The Secretary appointed a special Committee of three members to put before the Legislature the matter of securing the adoption of the A.S.M.E. Boiler Code by the Legislature of Georgia.

We have held two meetings this fall, and at the October meeting Mr. Brookes presented a paper on the Code and offered several constructive suggestions looking toward the matter of securing the adoption of the A.S.M.E. Code by the Legislature of Georgia. The Secretary appointed a special Committee of three members to put this before the Legislature.

Regarding membership, we have done active work and our members rarely miss an opportunity to spread the doctrine of membership in the Society. The general attitude, however, is one of conservatism, seeking quality rather than quantity.

In public activities we have coöperated with the Resources and Conversion Section of the War Industries Board through the Society's Committee on Readjustment on War Industries. In Atlanta there is also an Engineering Committee appointed each year by the Mayor to advise the civic administration on engineering problems. This committee is made up of a representative from each of four national societies, and our Section is represented on this committee.

Baltimore, W. L. DeBaufre, Vice-Chairman: The Baltimore Section is organized under the constitution and by-laws as laid down by the parent Society. At a meeting of the Section in November, 1918, the Chairman and Secretary were appointed a committee to confer with representatives of the other technical societies and clubs with the object of establishing closer bonds of union between the engineers and chemists of Baltimore and vicinity.

It seems to be the consensus of opinion that it would be desirable for the national society to formulate from time to time certain very definite and limited questions on some particular feature of the relation of the mechanical engineer to his work, to legislation, to education, etc., and submit these questions to the various local sections for discussion.

Birmingham, W. P. Caine, *Chairman:* The chairman of each of the sub-committees of the Birmingham Section is a member of the Executive Committee. A committee was appointed last year to embody in our constitution the features of the model constitution adopted by the Council. They tried to retain as much of the present one as possible, and in addition to have the election of officers on the same democratic plan adopted by the Society.

It is suggested that speakers interchange between the sections. Could not the Local Sections Committee arrange a tentative tour of speakers that would assist the various program committees in arranging its year's work? Would it not also be a good plan for the Society's Research and Standardization Committees to outline just how they desire the local men to work?

The Section has undertaken the task of securing the passage of a proper bill for the protection of the public from boiler explosions and making the A.S.M.E. Boiler Code the standard of new boilers installed. The Alabama Technical Association has placed itself on record as favoring the adoption of the Boiler Code by the state legislature.

We are on record as offering our support to the City Commissioners in matters of a mechanical nature; and our services were offered to the director of the Conversion Section of the War Industries Board and to the Alabama Manufacturers and Operators Association. We find that our Section creates much more interest in the Society than was in evidence before its organization.

Boston, Elmer Smith, *Secretary:* Up to this year our Section included the territory within a radius of ten miles from Boston City Hall but has now been increased to a 25-mile radius, and in a southerly direction the territory extends 50 miles to include Fall River and New Bedford. The territory is particularly rich in membership material and we feel that there are fully 2000 engineers in the Boston Section territory who are eligible for membership.

The results of the efforts of the Membership Committee of the Local Section so far have not been satisfactory. The work has been carried on almost entirely by letter but a new plan is proposed which instead of letter writing will involve a personal interview with the candidate. This will preferably be done by someone personally acquainted with the prospect.

Chicago, Arthur L. Rice, *Secretary:* War activity has consisted in assisting in the recruiting of engineering units, men for special service, applicants for officers' training in engineer and ordnance branches, and coöperation in the sale of Liberty Loan bonds. It is hoped that in time a coöperative headquarters and engineering building may be established in Chicago.

Cincinnati, Prof. A. L. Jenkins, Member of the Executive Committee: Papers of general nature and interest that may be illustrated with lantern slides are preferable to those that are highly technical, involving considerable mathematics. Papers of a highly technical nature, involving equations and complicated diagrams are read in abstract.

From time to time the secretary of the Local Section encloses to the local members a request for suggestions on subjects for papers and men to present them. It is the intention of the Local Committee on Papers to urge members to present papers on subjects about which they are well informed and allow them ample time for their preparation. It is hoped that this policy will tend to eliminate "lack of time" as an excuse, and after a period will begin to bear fruit.

Members are requested to present names of those whom in their opinion are eligible and who would accept membership. Prospective members are approached by members who know them personally and see that their applications are sent in.

Cleveland, J. H. Herron, *Secretary:* The first meeting of the Cleveland Section, which was held purely for organization purposes, took place in October; a tentative constitution was adopted, which was subsequently approved. The Cleveland Section is unique in that it is a Section of this Society organized within the Cleveland Engineering Society; in other words, it is called the Cleveland Engineering Society Section of The American Society of Mechanical Engineers. We have been opposed in Cleveland to the Section idea for some years past; we felt that we should not divide our activities, that we should work as one body in

(Continued on page 192)

A. S. M. E. COMMITTEE ON LOCAL SECTIONS

ANALYSIS OF ACTIVITIES FOR 1918 REPORTED BY THE DELEGATES TO THE THIRTY-NINTH ANNUAL MEETING

Section	Members Dec. 1, 1918	Chairman and Secretary, 1918	Delegate to Annual Meeting, 1918	Organization by Committees (a) Executive (b) Sub-Committees (c) Joint (d) Coöperating with National Committees	Coöperating or Affiliated Bodies (a) Coöperative (b) Affiliated	Meetings Schedule (a) Technical (b) Joint (c) Public (d) Social (e) Contemplated	Technical Subjects (a) Meetings Held (b) Contemplated	Speakers and Visitors	Public Activities	War Activities	Representative on Aims and Organization Committee
Atlanta	41	Robert Gregg Wm. J. Neville	Robert Gregg	(a) (b) On Meetings	(b) Affiliated Technical Societies of Atlanta		(a) Pulverized Coal (a) A.S.M.E. Boiler Code		Coöperation with Mayor's Engineering Committee Coöperate with War Industries Board		E. F. Scott
Baltimore	101	A. E. Walden A. G. Christie	W. L. De Baufre	(a) (b) Papers, Research							A. E. Walden
Birmingham	45	W. P. Caine Jas. W. Moore	W. P. Caine	(a) (b) Program, Papers and Research, Membership (d) A.S.M.E. Boiler Code						War Industries Readjustment	H. M. Gassman
Boston	514	W. G. Starkweather Elmer Smith	Elmer Smith	(a) (b) Meetings, Membership, Social	(a) Engineers Club (a) All societies in annual dinner						A. G. Duncan
Buffalo	122	H. B. Alverson W. W. Boyd	C. H. Bierbaum	(a)	(a) Buffalo Engineering Society						C. H. Bierbaum
Chicago	496	C. E. Lord Arthur L. Rice	A. L. Rice	(a)) (b) Reception		2 (d) 5 (b) 2 (e)	(a) Fuel control (a) Auto power plant (a) Lawrence Avenue Tunnel (a) High pressure superheat (a) Technical Education (a) Industrial lighting (a) Fuel conservation (b) Sugar making	A. N. Talbot, Pres. A.S.C.E. C. F. Kettering, Pres. S.A.E.		Recruiting. Sold $3600 Liberty Bonds. War Industries Readjustment	C. E. Lord
Cincinnati	160	Geo. W. Galbraith J. T. Faig	A. L. Jenkins	(a) (b) Research, machine tools, industrial education, railroad engineering, gas and oil engineering, steam, electrical; membership, entertainment, papers, publicity	(b) Engineers Club of Cincinnati	3 (b)	(a) Coa (a) Shop Kinks (a) Readjustment of Industries			War Industries Readjustment	John T. Faig
Cleveland	249	E. S. Carman J. H. Herron	J. H. Herron		(b) Cleveland Engineering Society					War Industries Readjustment	E. S. Carman
Connecticut Bridgeport Hartford Meriden New Haven Waterbury	480	J. A. Norcross C. K. Decherd E. L. Fletcher C. F. MacGill Charles S. Blake M. D. Church C. K. Decherd C. M. Flagg, Jr. J. A. Norcross E. H. Lockwood Hugh L. Thompson Geo. H. Putnam	C. K. Decherd E. L. Fletcher C. S. Blake C. K. Decherd S. H. Barnum, 2d H. L. Thompson	(a) (b) Increase of Membership, Meetings, Publicity, Reception Dinner (a) (b) Increase of membership		(a) (b) (c)	(a) Coal conservation (a) Internal combustion engines (a) Battleships (a) Firearms (a) Factory Accounting, etc.	Ira N. Hollis, Past Pres. A.S.M.E. C. W. Rice, Secy. A.S.M.E. O. P. Hood, Bureau of Mines Simon Lake, etc.		War Industries Readjustment	I. P. Breckenridge
Detroit	240	E. C. Fisher F. H. Mason	F. H. Mason	(a) (b) Membership (c) Technical with D.E.S.	(a) Detroit Engineering Society	3 or 4 (c) per year	(b) Aircraft (b) Standardization (b) Heat Treatment			Coal Conservation War Industries Readjustment	R. Collamore
Erie	27	M. W. Sherwood J. St. Lawrence	M. W. Sherwood	(a)	(a) Engineers Society of N. W. Penna. (a) A.I.E.E.		(a) Industrial Management (a) Conservation of engineering materials	D. S. Kimball			C. M. Spalding

Section	Members Dec. 1, 1918	Chairman and Secretary, 1918	Delegate to Annual Meeting, 1918	Organization by Committees (a) Executive (b) Sub-Committees (c) Joint (d) Coöperating with National Committees	Coöperating or Affiliated Bodies (a) Coöperative (b) Affiliated	Meetings Schedule (a) Technical (b) Joint (c) Public (d) Social (e) Contemplated	Technical Subjects (a) Meetings Held (b) Contemplated	Speakers and Visitors	Public Activities	War Activities	Representative on Aims and Organization Committee
Indianapolis..	83	L. W. Wallace Chas. Brosman	L. W. Wallace	(c) Engineers' Club Committee	(a) Engineers' Club, S.A.E., Indiana Engineering Society, Architects' Association, Boston Tech. and Rose Tech.	(b) Every month			State Board of Advisory Engineers to Fuel Administrator		L. V. Ludy
Los Angeles..	69	Chas. H. McGuire F. J. Loyer	C. H. Repath	(a) (b) Membership, Papers, Research	(b) Joint Committee of the Technical Societies of Los Angeles	4 (e)	(a) Modern cement plant (b) Fatigue of metals		Committee on Manufactures coöperating with Los Angeles Chamber of Commerce		C. H. Repath
Milwaukee.....	107	W. M. White F. H. Dorner	W. M. White	(a) (b) Increase of Membership	(b) Engineers' Society of Milwaukee				Advised City authorities re local ownership of lighting systems; the automobile parking problem; and traffic problems of Milwaukee River	War Industries Readjustment	L. E. Strothman
Minnesota....	95	J. A. Teach Ray Mayhew	J. A. Teach	(a) (b) Increase of Membership, Papers, Auditing, Publicity (c) Duluth Committee	(a) Minnesota Joint Engineering Board	(a) Monthly	(a) By-Products Coking Industry (b) Mining and handling of ore (b) Smelting of iron ore (b) Manufacture of beet sugar				C. W. Tubby
New Orleans..	36	H. L. Hutson E. W. Carr, Jr.	J. L. Henning	(a) (b) Papers, Research, Increase of Membership	(b) Louisiana Engineering Society	(b) Monthly					J. L. Henning
New York	2260	W. W. Macon H. D. Egbert	W. C. Brinton			(c) Monthly		Marcel Knecht, Mem. French High Commission Brigadier-General L. R. Kenyon, British War Mission, etc.		Recruiting; Military Engineering Committee War Industries Readjustment	G. K. Parsons
Ontario.......	48	R. W. Angus C. B. Hamilton	R. W. Angus		(a) Engineering Institute of Canada	(a) (b) (c) Factory buildings of concrete					R. W. Angus
Philadelphia...	637	C. N. Lauer J. P. Mudd	J. P. Mudd	(a) (b) Research, Membership, Public Relations, Papers, Meetings, Boundary, Organization	(b) Engineers' Club of Philadelphia (a) All other Locals	(b) (d) Monthly	(a) Large Steam Turbine Design	W. H. Blood, U. S. Shipping Board		War Industries Readjustment	T. C. McBride
St. Louis.....	100	Lewis Gustafson J. P. Morrison	V. J. Azbe	(a) (b) Papers and Research	(a) St. Louis Engineers' Club	(b) (a) Monthly				War Industries Readjustment	L. Gustafson
San Francisco..	143	E. C. Jones George L. Hurst	R. Sibley	(a) (b) Papers, Research	(b) Joint Council of the Engineering Societies of San Francisco	(c) Pulverized-fuel Diesel engine	(a) Fuel conservation		Engineer appointed on California Railroad Commission; engineer on Board of Regents of the State University; legislation affecting status of engineers	Recruiting and collation of historical data for War Department War Industries Readjustment	J. T. Whittlesey
Worcester.....	125	E. C. Mayo Chester T. Reed	E. C. Mayo			(a) Coal conservation 3 (e)		L. P. Breckenridge Chmn., Fuel Conservation Committee	Federal Labor Board	Fuel Conservation	H. P. Fairfield

Cleveland, so that we could make the engineering profession as effective in its activities in Cleveland as possible. Therefore, when the Council saw fit to suggest that we might organize the Section within the Cleveland Engineering Society, we were delighted to do so and proceeded forthwith.

A section in our constitution provides for a governing body and executive committee composed of nine members. Three of this committee are members of both the Cleveland Engineering Society and the A.S.M.E., three are members of the A.S.M.E. living within the confines of Greater Cleveland; and the remaining three are selected from the section lying outside of the county in which Cleveland is situated.

We shall have possibly one meeting a month. Every third or fourth meeting we will make an all-day session.

There will be Committees on Membership, and on Meetings, which will, of course, include papers for the meetings, and probably a Committee on Research, although it is our thought that the Research Committee should work under, or our representative should be a member of the national Committee on Research.

CONNECTICUT, E. L. Fletcher, Bridgeport
Charles S. Blake, Hartford
C. K. Decherd, Meriden and the State Section
S. H. Barnum, 2d
Hugh L. Thompson, Waterbury:

We find it always adds greatly to the interest taken in our meetings to have officers of the Society present. We believe that the organization of the Connecticut Section with branches in the several leading cities of the state is along the right lines and will be productive of great good for the Society and the profession.

DETROIT, F. H. Mason, *Secretary:* We have an active joint committee consisting of members of the Detroit Section of the A.S.M.E. and the Detroit Engineering Society, which has been arranged as a technical committee to assist the Civic and Local Federal Authorities on the question of "Fuel Conservation" and coöperating with power-plant owners to the end of obtaining fuel economy in their plants.

Just prior to the declaration of war, we had a very active movement afoot here in Detroit, to take over under the general direction of the Detroit Engineering Society, a property which would be developed into a joint engineering building, the plan being to make a home for all of the engineering societies in this district, with very active coöperation between them, and it is expected that this project will be revived just as soon as general conditions will warrant, when such a project could be financed. We believe that such a movement will be directly in line with a sentiment which seems to be growing strongly among the national societies, i.e., to have a very close affiliation between the national societies, in the different localities, and in connection with local engineering societies, and there is no reason why Detroit in the very near future cannot bring about a workable plan.

ERIE, M. W. Sherwood, *Chairman:* Effort can most profitably be directed, I believe, toward the securing of additional members. The existence of a strong local engineering society with an initiation fee of only a dollar and annual dues one-fifth of ours has made it difficult sometimes to convince a prospect that the advantages offered by membership in the national society justified the added expense. I believe the best argument is to present the fact that the national organization is to become a prominent factor in the reconstruction of business along new lines made necessary by the war and that new men can best help the great body of engineers, in playing their important part in this work, by joining and supporting a national organization to unify their efforts and secure, through concerted action, results which could never be achieved by any number of small organizations working independently.

The question of reaching the membership outside of the city in which the meetings of the section are usually held, is a problem that I would like to know whether other sections have solved. We occasionally get some of them out to attend meetings, but very few. We have discussed the possibility of holding one of the section meetings in Oil City, although no definite plans have been made thus far. It would be natural for those outside to feel that the section is principally for the benefit of those living where the meetings are usually held.

INDIANAPOLIS, L. W. Wallace, *Chairman:* The Local Section has a constitution and by-laws governing its operation. Since this has been formulated, there is no occasion for continuation of like committees.

The Indianapolis Section very enthusiastically entered into the idea of having a joint meeting of the Mid-Western local sections in October, 1918. We were much disappointed that it became necessary to postpone that meeting indefinitely. The unanimous expression is for the holding of that meeting early next spring. The Indianapolis Committee feels that it can be made a great success. We, therefore, strongly recommend that the Sections Committee authorize such a joint meeting as was proposed for October to be held in the Spring, possibly in March or April. We stand ready to put our efforts into the movement in order that it may be a success in every way.

The State Board of Advisory Engineers to the State Fuel Administrator was largely formed through the activities of the members of the Indianapolis Section. An engineer was placed upon the State Council of Defense through a suggestion of the Indianapolis Engineers' Club.

LOS ANGELES, C. H. Repath, *Representative:* The Research Committee is working out a plan for the publication and preservation of experimental data obtained in the several universities in this section. It has also been suggested that the Society's Research and Standardization Committees outline subjects on which we might obtain valuable information, as there are several mechanical-engineering laboratories at our disposal.

Our Society is represented on the Chamber of Commerce of our City by a Committee on Manufactures, to which the officials of the Chamber can refer for expert information.

MILWAUKEE, Fred H. Dorner, *Secretary:* The Engineers' Society of Milwaukee appointed a committee to investigate the feasibility of the city owning its own lighting-distribution system. Our society also submitted a report to the city, upon request, of the solution of the automobile-parking problem, for the city of Milwaukee.

We also appointed a committee to investigate the feasibility of closing up the Milwaukee River for lake traffic and building a 50-ft. roadway on each side of the river, with permanent arch bridges instead of the movable bridges now in use.

MINNESOTA, Jacob A. Teach, *Chairman:* Seventy-five per cent of our membership is concentrated in the cities of Minneapolis and St. Paul, hence the Twin Cities logically serve as the headquarters of the Minnesota Section. Since the inauguration of this Section approximately seven years ago and until the present year, our monthly meetings alternated between the two cities. That was not a good arrangement for two reasons: first, we had no place which we could claim as permanent headquarters; and, second, the average attendance at the meetings was lower than it should have been due to the inconveniently long trip the members from each city have alternately been obliged to take. To correct that situation we made arrangements at the beginning of this season to hold all our meetings at a commercial club in the district midway between the two cities.

NEW ORLEANS, E. W. Carr, Jr., *Secretary-Treasurer:* The following is a resolution passed by the Louisiana Engineering Society at their meeting on November 18, 1918:

> WHEREAS, it has come to our knowledge through the city newspapers, that the Commissioner of Public Property of the City of New Orleans, will resign his office on December 1, 1918, and
>
> WHEREAS, it is our opinion that the administrative and executive duties falling to the Commissioner of the Department of the City Government can be satisfactorily and efficiently performed by a competent and capable engineer as evidenced by the experience of more than a hundred cities in this country that have found it economical and advantageous to employ engineers as City Managers; this result being attributable to the fact that engineers are by education, training and experience qualified to administer to the physical welfare and comfort of communities, and
>
> WHEREAS, some of the large problems confronting our City Government and calling for solution in the near future, as for instance,

the street railway situation, the disposal of garbage and municipal waste, the introduction of natural gas, are essentially engineering problems.

Therefore Be it Resolved: That the Louisiana Engineering Society, both as engineers and as citizens interested in the welfare of our City, respectfully urge upon the Mayor and Commission Council of the City of New Orleans the desirability of electing as Commissioner of Public Property some qualified and competent Civil Engineer who will have an administrative voice in the solution of the economic affairs of our City.

Be it Further Resolved: That the Louisiana Engineering Society tender its hearty coöperation and services to the Mayor and Commission Council in the furtherance of the above object, and that the President of this Society appoint a Committee of four members to serve with himself to represent the Society in any conference on this subject.

Many members of the Louisiana Engineering Society have assisted in problems relating to the development of New Orleans as a port, as a manufacturing center, and as a residential city; to the Industrial Canal now being put through between the Mississippi River and Lake Pontchartrain; the proposed bridge or tunnel across the Mississippi River; the imminent introduction of natural gas to the city from Terrebonne fields; and the extension of our port facilities by means of public warehouses and elevators.

New York, W. C. Brinton, *Representative:* It may not be realized by delegates from other sections, especially those of smaller size, that the problem in New York is chiefly one of organization. Scarcely a move can be contemplated with our 2200 members but it becomes necessary to handle a large amount of correspondence, telephone or conference work. The New York Executive Committee believes that the number of members in New York City is large enough to justify a paid secretary who will devote most, if not all, of his time to the New York Section. The financial aspect of such a plan must of course be considered and the Executive Committee will be glad to go thoroughly into the subject with the properly constituted authorities.

It is the recommendation of the New York Section Executive Committee that there be a study made of the basic facts regarding the A.S.M.E. membership, activities and finance similar to the report "Association Data Visualized" recently published by the Y. M. C. A. covers practically every phase of the association's activities and many of the curves date back as far as 1866. The New York Section Executive Committee believes that a report of this kind would be of the very greatest assistance, not only to the New York Section but to the Council and the local sections throughout the country. It is of course assumed that work of this kind once started would be kept up so as to be available for all officers and members of committees.

The suggestion that we are working toward here in New York is one which I believe would be feasible in a number of the other cities. For instance, in Boston they have a potential membership, according to estimates, of four times their actual membership. I suppose that that holds true in New York—that our potential membership in New York is certainly four times, in my opinion, what our actual membership is. If that is true, why should not we then organize in such a way as to get in more members, and to do a larger piece of work in our community?

In other words, we feel here that in this Section we have a problem big enough to justify the time of a man all the time as secretary to the New York Section, without regard to the work that he might be able to do on the national matters also. If we can get the combined service of a man in the New York Section, and then to work in on the national problem so as to get any benefits out of the New York experiments, that we might be able to do here, available for the rest of you, I believe it would pay all the better. We do not want to take up anything of that kind unless we have the full sanction of this Committee and the Society as a whole.

Ontario, Professor Robert W. Angus, *Chairman:* Our secretary is keeping in touch with the manufacturers' requirements in the way of research, with a view to assisting in any possible way. We are also in touch with the Canadian Government's Industrial Research Committee's work, and hope to coöperate there as well. Our last executive meeting was almost entirely spent on a discussion of how engineers might suggest to the Government means of meeting the great problems incident upon the close of the war, and tide over the period of reconstruction and readjustment.

Philadelphia, John P. Mudd, *Secretary:* The regular election of the Executive Committee of the Philadelphia Section took place at the end of the fiscal year 1917-1918. About the first of August, these men met at the Engineers' Club and began to formulate plans for the coming year. Meetings were held every week or two, until early in September.

The meetings of the Section have, as heretofore, been held on the fourth Tuesday of each month. For the last several years, joint meetings have been held with the other Societies, principally The Franklin Institute, the Philadelphia Engineers' Club, American Illuminating Engineering Society, and American Society of Heating and Ventilating Engineers. It is under contemplation to hold one of the regular meetings in Wilmington, Del. This city contains a very large number of the Philadelphia membership.

It has been our experience that the best way to arouse interest in the Society is through personal interviews.

Local matters pertaining to public relations are first brought before the council of the Associated Engineering Societies. If the council decides that any matter brought before it is of general interest the weight of the entire organization is put behind the movement and greater results are obtained than could be secured by any society alone. If the council decides adversely, the matter is referred back to the section presenting it for such action as the section sees fit to take.

In regard to boundaries we would suggest that there should be some arrangement by which members can be accredited to those sections which are already established.

We would further the suggestion that the A.S.M.E. Council hold regular meetings with the Local Sections, we can think of nothing that would be a greater stimulus to the activities of the Sections.

San Francisco, Robert Sibley, *Representative:* With an idea of vastness of country involved and magnitude of engineering effort called forth with problems new to engineering design, members of the Society can readily appreciate how our two sections in the Far West, situated over 3000 miles from the Society headquarters, find contact with the Society as a whole extremely difficult and often find our arguments to induce our fellow-engineers to join the Society of little avail. For under such circumstances since few of our men rarely visit New York City, and since the large number of questions discussed through the journal of the Society are wholly foreign to problems that vex us for solution, it is difficult for local engineers, not members of our Society, to see wherein a fair return is to be received for the annual dues required for membership.

So those of us in the Far West who have this matter at heart see in the fuller development of the local section idea the only ultimate hope for profitable helpfulness both to the member and to the Society as a whole in its work for the betterment of the engineering profession—not alone in New York City but in the far nooks and corners of this broad country of ours. With this ideal in view it would seem that for the ultimate development of Society effort west of the Rockies there should be established as reasonably soon as circumstances will permit duly organized sections in the seaport centers such as Seattle, Portland, San Francisco, Los Angeles, and inland centers such as Spokane, Butte, and Salt Lake City. Such a development of Section activity in the Far West would contribute four vital factors in furthering engineering-society activity:

1 It would interest local members as nothing else can.
2 It would make possible enlarged membership.
3 It would make the Far West more accessible for eastern members who are now either coming to these districts of the West in ever-increasing numbers, or are en route to oriental ports where new activities are engaging our membership.
4 It would immeasurably build up a larger and more useful A.S.M.E., at least, so far as our district of the nation is concerned.

Some concrete examples of the good that has already been accomplished by the Joint Council of the Engineering Societies of San Francisco are as follows:

1 Definite dates have been fixed for the holding of individual section meetings to avoid conflicts in meeting nights.

2 The bringing about of a saving in labor and expense in secretarial work by joint use of addressograph and many economies in clerical help.

3 The joint offering of engineering talent for war service and for historical data now being called for by the War Department.

4 Joint action on necessary legislative matters such as urging the appointment of an engineer member of the California Railroad Commission, an engineer member of the Board of Regents of the State University and legislation affecting the legal status of engineers in the commonwealth of California.

5 The establishing of an effective Service Bureau in which active effort is made to secure accurate information on vacancies open in engineering activities and the placing of capable applicants in employment.

6 The holding of two to three joint meetings of all national engineering societies annually.

In the Far West we realize full well the trying stress financially upon the mother Society to meet the vast outlay necessary to put through the progress of national helpfulness the Society has undertaken. It is the firm conviction, however, of your far-western sections, that more effort and financial assistance devoted to this growing district of our country would not be a matter of charity, but the actual money returns in an immediate influx of new members would not only strengthen the Society nationally but would create an increasing financial revenue in dues that would prove a permanent gain many times the outlay involved, and in addition to this financial assistance we need more personal contact, we need the broadening assistance derivable alone from hearing men of eminence in our profession from eastern centers as well as men familiar to our localities, and we hope some means may be secured whereby the leaders when visiting our district may make themselves better known and advantage taken of their helpful council.

WORCESTER, E. C. Mayo, *Chairman:* During the Fall of 1917 one local meeting was arranged. Instead of having a number of local meetings during 1918 it was decided to devote all our energies towards the preparation of the Spring Meeting, which took place in June. During the summer and fall months of this year a large number of the local members have been interested in the conservation of coal. We were delayed in getting our new Committee for 1918-19 organized and this fact coupled with the unusual interest shown in Worcester on all war activities has taken considerable of our time and prevented any local meetings this fall.

New Year Meeting of New York Section

THE New York Section opened its 1919 season with an enthusiastic and well-attended "New Year" meeting on the afternoon and evening of January 14. The program comprised an address by L. C. Marburg, Chairman of the Society's Committee on Aims and Organization, on the work of the Committee; a paper by Edwin J. Prindle on The Patent Situation in the United States; and a series of brief addresses by W. W. Macon, H. L. Aldrich and A. J. Baldwin on their experiences abroad as members appointed by President Main to represent the Society on a delegation of technical editors who were guests of the British Government on a trip of inspection of the battlefields of Europe and of the manifold industrial activities of England in war time. Mr. Baldwin supplemented his remarks by numerous stereopticon views showing the devastation wrought by the enemy on the cathedrals, towns, factories and mine heads of Flanders and France. Geo. K. Parsons, New York Section representative on the Committee on Aims and Organization, presided over the afternoon meeting. A buffet supper was served at 6:30 p. m.

THE SOCIETY'S AIMS AND IDEALS

L. C. Marburg, Chairman of the Aims and Organization Committee, brought to the attention of the meeting the questions which his Committee is considering in view of the changes which appear to be under way in the viewpoint of engineers as well as among others in the world at large. These questions were very fully reviewed in the last number of MECHANICAL ENGINEERING in the report of Mr. Marburg's address at the Annual Meeting, and in the present address he urged upon his hearers the need for coöperative effort to help solve the problems with which the Committee is confronted; and possibly the greatest of which was that of arousing the membership to the realization of the magnitude of the task and of the necessity for a general and generous response to the Committee's efforts.

The program of the Committee is divided into three main divisions: (a) Relations of the Mechanical Engineer to His Work; (b) Relations of the (Mechanical) Engineer to the Community; (c) Relations of the Mechanical Engineer to Other Engineers.

Without changing the meanings of these headings the speaker said we might call the first one "professional aims"; the second one, "public aims"; and the third one, "organization."

Under professional aims, it is the purpose of the Committee to determine from the membership what subjects the Society is now interested in or should be interested in more than it has been in the past; for example, with regard to standardization and research it is expected to learn from the committees on these subjects what they believe ought to be done in addition to what has been done. Then, as to the scope of papers and discussions which are supposed to relate to "progress in the art of mechanical engineering and allied sciences," in what way is "allied sciences" to be interpreted? Does it include economics and welfare work and other general subjects which the Society frequently discusses? If not, should not the scope of the Society be redefined?

Shall MECHANICAL ENGINEERING be published more frequently than at present? In close connection with this is the question of the classification of literature so that articles may readily be found.

In conducting and assisting research, another topic, should the individual societies carry on this work or should it be done by united action as in Great Britain through the suggestion of the Conjoint Board of Scientific Societies?

The same thing holds also with respect to standardization. Other subjects are education and special training, and legislation and jurisdiction affecting the engineering profession.

In the second major group, the Relations of the Engineer to the Community, should engineers as a group take a greater interest in public affairs and make available to the community the experience of the group in matters with which they are familiar?

Under the final heading, Relations to Other Engineers, in what way should united action be secured? Should there be a union of the four founder societies, or should other organizations be included, including certain of the local societies? Under this heading would come also social activities—the advisability of having clubs with exchange privileges, so that an engineer from one city, connected with one club, could go to a club in another city.

At the conclusion of Mr. Marburg's address, J. E. Johnson, Jr., in response to the chairman's request for suggestions, said that the present seemed to be a time of great unrest in the engineering profession all over the country, comparable to the political unrest in Europe. As Mr. Marburg had said, it would be comparatively simple to consolidate the various societies—they were already partly consolidated, and what good had resulted? There was the Engineering Council and also the Engineering Foundation. The latter had been established to promote research, but the main thing it had done within his knowledge was to finance the National Research Council until the Government had taken it over.

Similarly, the Engineering Council was supposed to represent all the engineers, but on one important occasion, when they had been requested to coöperate with the legal and medical professions in protesting to Congress against the imposition of the unjust 8 per cent tax on professional incomes, they had done nothing, so far as he was aware.

If the engineering societies in the broad sense, along with some of the economic and other related societies, were so consolidated that membership in each would mean membership in the national

society, and every district of a given number of engineers had a head who was elected a member of the Engineering Council, meetings of the latter could be held at which the various problems could be discussed and results obtained. The funds of the Engineering Council could be put to no better purpose than to pay the traveling expenses of real representative men from all over the country to come to New York and discuss what should be done and discover means for doing it.

Charles Whiting Baker said that as a member of the Engineering Council he could assure the previous speaker that the income-tax matter had been extensively considered by that body. There was no question as to its injustice, but as to whether anything would be accomplished at that time by making a protest; and the majority of the Council felt that with the war going on it would perhaps be unwise and unpatriotic for engineers as a class to protest against any tax assessed on them, however unjust.

As to the work of the Council, it had been in session that very afternoon dealing with the matter of the abrupt dismissal of some 370 engineers engaged in rapid transit work as a result of unwarranted interference by the Board of Estimate and Apportionment, and it proposed to do everything in its power to right that wrong and let the public know what was going on.

He desired to impress on those present, however, that while the Engineering Council was created to care for just such matters, it was the duty of every Local Section of the Society and the Society itself to work for the Council.

"If something comes up in any locality where the Section can speak," said Mr. Baker, "it is the business of that Section to adopt resolutions and appoint committees to see the men who have charge of affairs—use their influence; and if, say, twenty societies adopt resolutions on the same thing, bringing into play the cumulative effect, the engineer will go forward more rapidly in doing the things he wants done than if he waits for the general movements in his own organization. Let him use his organization instead of trying to do too much to consolidate. There is danger of relying on consolidations and the force of great numbers. The fact is that oftentimes a big organization finds it difficult to do things a small one can do very well."

The discussion closed with the proposal of the following resolution by J. E. Johnson, Jr., which was duly seconded, put to vote and carried:

Resolved, That arrangements be made looking to a joint meeting of the New York sections of the four Founder Societies (not necessarily exclusive of some of the other representative societies) to be held at a later date.

Charles Whiting Baker said that if such a meeting was to be held, someone must have charge of it, and he accordingly offered the following resolution which was put to vote and carried:

Whereas, The work of the Committee on Aims and Organization is invested with matters of most fundamental and primary importance to our Society, be it

Resolved, That the New York Section Executive Committee be empowered to appoint a sub-committee to assist our representative, Mr. G. K. Parsons, to the end that the members of our Section may be fully informed and have ample opportunity to voice their ideas on Aims and Organization of the Society.

The Patent Situation in the United States

At the conclusion of the discussion, Mr. Edwin J. Prindle presented his paper on the patent situation in the United States, in which he said that the desirability of increasing the incentive to produce inventions had been shown by the exceedingly important part they had played in the war. Improvement in the efficiency of our Patent Office and patent system would work to the improvement of the inventor's position, and important among the matters that would contribute to this end would be a single court of appeals, making an independent institution of the Patent Office, increasing the force and salaries in the Patent Office, and changes in the law providing compensation for infringement of patents.

Mr. Prindle is a member of the Committee of the National Research Council appointed at the request of the Society of Patent Office Examiners to investigate the Patent Office and its system and recommend provisions for increasing the efficiency of the Patent Office. Although his paper embodied only his personal views, it may fairly be interpreted as representing also the views of the Committee. Since the paper was presented the report of the Committee has been officially approved by the National Research Council, the Engineering Council and the Commissioner of Patents, and an abstract of it is therefore given elsewhere in this number.

Trip of Technical Editors to England and France

At the evening session, W. W. Macon, who presided, explained that the delegation of which he had been a member consisted of 15 trade and technical journalists who had been invited by the British Government to come and see with their own eyes and then report to their readers the unstinted efforts Great Britain was making to insure a victory in the titanic struggle in which she and her allies were engaged. After referring to the varied forms of entertainment that had been accorded the delegation, the visits they had made to engineering works, to the Grand Fleet and the battlefields of Flanders and France, and to a projected cross-Channel flight that had to be abandoned on account of weather conditions, he introduced Mr. Aldrich as the next speaker.

Mr. Aldrich described strikingly the 14-day voyage of the party on the zigzag course made necessary by the submarine menace. Arriving in England he was first impressed with the stupendous amount of work that had been performed by women during the war. What the outcome would be when the troops returned was conjectural, but it was believed that there was much work, especially of the lighter sort, that would continue to be done by the women. In the matter of trade there was a feeling that there would be severe competition in export trade and in shipbuilding with the United States after the war, but this was tempered by the reflection that there would no doubt be room for all.

Great Britain had expended a third of her gross wealth in "carrying on" and the taxes already high would doubtless have to be supplemented by tariff imposts. The income tax was very high and began at very low incomes, but so far it had not impinged on labor, although the incomes of many of the workmen were well above the lower taxable limit.

American engineers had accomplished things believed impossible in France, both in battle and in works of construction. At St. Nazaire, on the Loire, where our troops disembarked, tidal gates maintained a 20-ft. depth of water in the river. Along the miles of water front utilized there were innumerable cranes of every size and description; in fact, the handling facilities were the most complete he had ever seen. Our engineers had fitted up a huge locomotive repair shop in which 14 engines could be assembled in a day. Many German prisoners were employed in this work.

The speaker commented on the deliberateness with which the French were accustomed to bring about changes, and instanced the case of a needed concrete reservoir that was constructed by American engineers at St. Nazaire and completed in less time than it would have ordinarily taken to obtain the necessary authority. Miles of unnecessary railway haul were similarly saved by building a cut-off around an angle in the road to Paris. In both cases the engineers had gone directly to the highest authorities and by their forcefulness had eliminated the red tape of procedure.

In the six months ending on September 1 the Americans had laid 250 miles of railway track and had constructed, in a swamp above St. Nazaire, 180 huge warehouses having a total of over 50,000,000 sq. ft. of storage space. There were over 20,000 American freight cars in France and several thousand locomotives. Thousands of motor trucks were also used, and in one day 1500 were received from America.

Mr. Baldwin, who was then presented by the Chairman, said that on the arrival of the delegation, England was without lights and in gloom. Three days later, the armistice having been signed, they went almost delirious with joy at their release from the aircraft menace.

The party had been shown the Grand Fleet—an imposing

spectacle with its boulevards of battleships and avenues of cruisers—and had, among other places, been taken to the vast shipyards of Glasgow. It had been their intention to cross the Channel in a huge airplane of 127 ft. spread and a capacity of 40 passengers—built for bombing Berlin—but weather conditions forbade.

On the Continent they rode over the battlefields in motor cars and visited practically every section from Flanders to Lorraine, passing through La Bassée, Ypres, Vimy, Souchez, Le Catalet—where the old 7th Regiment of New York and the 23d of Brooklyn were the first to cross the Hindenburg Line—Rheims, Hill 108 with its two miles of winding underground passages, and so on. Among the souvenirs he had acquired were two German shells bearing the date of their manufacture—15 years before the war, which seemed to him to be evidence of a sinister purpose long under consideration.

Mr. Baldwin then had shown the photographic views mentioned earlier in this account, and accompanied their presentation with brief descriptive comments. Continuing his address, he said that industrial conditions in Europe were much the same as in America, but more intensified. All countries were looking for export markets and the competition would be keen, but the world's shops and warehouses were empty now and there would be work for all.

In closing, he spoke of the word "dependence" as typifying the conditions prevailing in the old, dark days of Europe, out of which its peoples had struggled after long years into "independence." But our own magnificent national experiment had shown that there was something in the relations between states that transcended in importance even the concept of independence, and this was "interdependence"; and from the proceedings at Versailles he believed would issue the charter that would establish this salutary relation and insure its continuance for generations to come.

Fuel Meeting at Boston

THE Boston Section held an interesting meeting on Fuel on December 19, at the Wentworth Institute. David Moffat Myers, Mem.Am.Soc.M.E., Advisory Engineer to the U. S. Fuel Administration, delivered the address of the evening on the subject of Results of Fuel Conservation. Remarks were also made by Prof. A. E. Norton of the Massachusetts Institute of Technology and by Perry Barker, consulting fuel engineer. At the close of the address a motion picture was shown, entitled Coal is King. Mr. W. W. Crosby presided.

Mr. Myers reviewed the successful results of conservation that had been effected by the Fuel Administration and showed the urgent need for a continuation of the work so successfully begun, closing with suggestions as to the broad scope which it might assume in the future. The following summary brings out these points:

As nearly as can be estimated from the reports from the states, the first six months of the active prosecution of the program resulted in an annual saving of 7,000,000 tons of coal in the power plants, 1,000,000 tons on the railroads and 4,000,000 tons in such items as the introduction of the skip-stop on electric railways, the reärrangement of power plants to avoid duplication, the substitution of central power for that produced by isolated plants where that proved advisable, and the larger utilization of water power and savings in domestic consumption. These savings were all in the direction of constructive conservation which has for its slogan "Maximum Production of Industry with Minimum Waste of Fuel." They were in addition to such savings as were effected by the curtailment or restriction of industry and were only a fair beginning of what may be done by continuing the practice of steam and fuel economies. It will be comparatively easy to increase this figure to 50,000,000 tons a year. The latter at $5 per ton would pay one-quarter of the interest on our national war debt.

It was thought by many when the Government took up the plan for inspection of power plants that there might be some resentment on the part of owners with the idea of having their private business interfered with by volunteer engineers in the service of the Fuel Administration. But owing to the patriotic spirit of helpful coöperation with the plant owner with which the state authorities and the administrative engineers and their committees introduced and carried on their work, this objection was overcome and they gained the hearty backing and good will of the manufacturers.

Letters are being received in Washington from far and wide asking that some scheme of fuel conservation applicable to power plants be adopted as a permanent measure. Many manufacturers have written appreciatively of the saving they have been able to effect as a result of instructions received from the volunteer inspectors of the Fuel Administration, or from the standard recommendations of the administration.

From the beginning of the campaign it has been in the minds of engineers that a second phase of the power-plant program might soon become appropriate. The efficiency of any process such as the production of energy is equal to the efficiency of operation multiplied by the efficiency of the equipment. That is to say, the efficiency of the man multiplied by the efficiency of the machine.

We have so far been considering almost exclusively the efficiency of the man behind the machine or the man in front of the boiler or the man on our factory committee, but up to the present time have given little or no official attention to the efficiency of the equipment. This question involves the matter of initial design and proper supervision of any changes that are contemplated in a plant in order that they may be made strictly in line with what will produce the highest efficiency in the use of fuel. Just before the armistice was signed Mr. Myers had proposed this question for discussion by the Committee of Consulting Engineers of the Engineering Council who now have the matter under advisement.

The general idea is to formulate what might be termed "A Ten Commandments of Power-Plant Design," treating only of fundamentals and not of specific design. The reason for desiring such a measure is obvious to any engineer. Time and time again we have all seen so-called "improvements" installed by manufacturers using steam-consuming or steam-generating equipment entirely unsuited to the conditions under which they are to be used. When this is done it means that for years and years to come an entirely unnecessary waste of fuel will continue owing to the ill-advised installation.

The same reasoning of course applies to new plants. Each case requires an individual diagnosis by a competent engineer and preferably one whose interest is solely that of the purchaser. At the same time, after making his diagnosis, a competent engineer will make recommendations based on certain fundamentals and it is these basic fundamentals which we now desire to formulate. The programme of conservation cannot be considered comprehensive unless it treats both of operation and equipment.

In closing, Mr. Myers told what had been done or was contemplated in issuing bulletins and moving-picture films for instruction purposes. A 50-minute film showing good and bad operation in boiler plants had been prepared, and nine engineering bulletins were announced, but most of these were now at press and not yet ready for distribution. The subjects are as follows:

Boiler and Furnace Testing
Stoker Operation
Boiler-Room Accounting Systems
Oil Burning
Fuel-Gas Analysis
Saving Fuel in Heating Systems
Saving Steam and Fuel in Industrial Plants
Burning Mixtures of Anthracite and Bituminous
Boiler-Water Treatment.

It is understood, also, that the valuable bulletin produced by the Massachusetts Advisory Committee is being reprinted for general distribution by the Washington administration.

Enlisted in the service of fuel conservation have been 1500 volunteer engineer inspectors of power plants, many of them

members of this Society, in addition to the several thousand acting on town and factory committees.

Members of the A.S.M.E. have been in charge of the power-plant program as Administrative Engineers in Massachusetts, New York, Pennsylvania, Minnesota, Missouri, Indiana, Maryland, Ohio, Illinois, Tennessee, Virginia and Florida.

The Fuel Administration has received advice and help through the Committee of Consulting Engineers of the Engineering Council in the initial creation and further development of its national plan of conservation. The average power-plant owner did not realize the possibility of important economies to be readily accomplished in his plant until the engineers working solely in the interests of humanity devised a system of education and of personal assistance to him.

From start to finish this has been the service primarily of engineers. It has been a big success, and of great value to our country in her time of need.

If the work of conservation is to be continued and further developed as a widespread permanent institution in such manner as to meet peace conditions satisfactorily, the engineers must devise suitable ways and means, for the country now looks to them with increased confidence.

We should look forward to the future recovery and utilization of the valuable by-products of coal resulting from its low temperature distillation. No raw coal containing these by-products should be burned directly under boilers. The resulting carbonized coal should be the boiler fuel of the future. This is one of the greatest steps toward true conservation of fuel ever inaugurated and should be developed as rapidly as possible.

Water powers should be further developed and utilized, although according to Steinmetz, even when these resources are utilized to the ultimate extent they can care for only a very small fraction of the power demands of the future, and coal will always of necessity remain our mainstay for heat and energy.

Coal is a national resource, a common possession of the people. It is unfair that a progressive plant owner should go to great pains and expense to use his share efficiently while his neighbor continues to waste extravagantly in a badly designed plant and by improper management.

These, briefly, constitute some of the problems before the country today and Mr. Myers expressed his confidence that they can and will be solved by engineers.

Meetings of Sections

ATLANTA SECTION

The Atlanta Section held its regular monthly meeting on Friday, December 27, in the Lecture Room of the Carnegie Library.

At this meeting our Chairman made a report covering his recent trip to New York as the Section's delegate, and our delegate to the Committee on Aims and Organization also reported.

WILLIAM J. NEVILLE,
Secretary.

BALTIMORE SECTION

A meeting of the Baltimore Section was held on December 18, at which Mr. Hess read an interesting paper on Electric Furnaces as Applied to Steel Making.

On January 27 the Secretary, Mr. Rice, attended a meeting of the Baltimore Section, and addressed the members informally.

A. G. CHRISTIE,
Secretary.

BIRMINGHAM SECTION

J. R. McWane and Oscar Wells were the speakers of the evening on January 23, when the Birmingham Section held a meeting at the Tutwiler Hotel. The addresses of these gentlemen were on the subjects of labor and finance. J. J. Greggan read an abstract of President Main's President Address, Broader Opportunities for the Engineer.

JAMES W. MOORE,
Secretary.

BOSTON SECTION

Meeting held on December 19 on Fuel. Reported elsewhere in this issue.

BUFFALO SECTION

An interesting meeting was held by the Buffalo Section at the Hotel Statler, on the evening of January 29. The address of the evening was delivered by Nathan L. Lieberman, on the subject Horse Power Requirements of Aeroplanes and Power Consumption through Parasite Resistance.

W. W. BOYD,
Secretary.

CHICAGO SECTION

A get-together meeting of the Chicago members was held on Monday evening, January 13, at the Engineers' Club. The meeting was preceded by an informal dinner, at which the members met Mr. Rice, the Secretary of the Society.

On January 27, M. J. Kermer, Mem.Am.Soc.M.E., delivered a timely address on Sugar Manufacturing.

ARTHUR L. RICE,
Secretary.

CONNECTICUT SECTION

Bridgeport Branch

The Bridgeport Branch held a meeting on industrial management on December 18. J. C. Spense of the North Grinding Company delivered an address on Vestibule Schools, Prof. H. B. Bogell of Yale University delivered an address on The Education of Radio Operators in Connection with Airplanes, A. W. Lebouef, Educational Director, Remington Arms U. M. C. Company, delivered an address on Shop Education.

C. F. MACGILL,
Secretary.

Hartford Branch

Lieut.-Com. D. C. Buell delivered an interesting address on The 50-Caliber 14-in. Navy Guns with Railway Mount before the members of the Hartford Branch.

MAYNARD D. CHURCH,
Secretary.

New Haven Branch

A meeting of the New Haven Branch was held at the Mason Laboratory on Wednesday, January 8, at 8 p. m. Douglas K. Warner, Jun.Mem.Am.Soc.M.E., read a paper on The Friction of Ball Bearings. This paper described several machines that have been used to measure tee friction of ball bearings and discussed the characteristics of this kind of friction.

E. H. LOCKWOOD,
Secretary.

Waterbury Branch

A luncheon meeting was held at the Hotel Elton on November 25, at which the officers for the fiscal year 1918-1919 were elected.

On Monday evening, January 6, there was held in the hall of the Mattatuck Historical Society a meeting to which were invited the Civil, Chemical, Electrical, Gas, Mining and Mechanical Engineers residing in that center. An interesting address was given, describing Waterbury's Water Supply.

HUGH L. THOMPSON,
Secretary.

DETROIT SECTION

A meeting of the Detroit Section was held on Saturday evening, January 11, at the Detroit Board of Commerce, at 8.15 p. m. There were two speakers of the evening, viz., Dean M. E. Cooley, University of Michigan, President of the Society, and Mr. Calvin W. Rice, Secretary. Dean Cooley spoke informally on An Unoccupied Rung in the Engineer's Ladder of Fame. Mr. Rice delivered an address on the subject of Broader Opportunities for the Engineer.

The meeting was preceded by an informal dinner at 6.30.

FREDERICK H. MASON,
Secretary.

INDIANAPOLIS SECTION

An informal meeting was arranged for January 15, to give the Indianapolis members an opportunity to meet Secretary Rice, and talk over with him problems of the Section, plans for the Spring meeting, etc.

L. W. WALLACE,
Secretary.

MILWAUKEE SECTION

The regular monthly meeting of the Engineers' Society of Milwaukee was held under the auspices of the Milwaukee Section of the A.S.M.E. on Wednesday evening, January 15, at 8 o'clock, at the City Club.

Henry L. Dale, Major of Engineers, U. S. A., gave a talk on Engineering Experiences at the Front. A buffet luncheon was served for the convenience of the members.

Fred. H. Dorner,
Secretary.

MINNESOTA SECTION

An illustrated lecture was given on December 17 by Professor E. H. Comstock, School of Mines, University of Minnesota, the subject being Mining Iron Ore in Minnesota.

Professor Peter Christianson, also of the University of Minnesota, delivered the address of the evening on January 6. The meetings were held at the Section's regular meeting place, the Midway Branch of the St. Paul Association of Commerce.

Ray Mayhew,
Secretary.

NEW YORK SECTION

Meeting held on January 14. Reported elsewhere in this issue.

PHILADELPHIA SECTION

Secretary Rice attended the meeting of the Philadelphia Section held at the Engineers' Club, on Tuesday, January 28. The address of the evening was delivered by William B. Dickson, Vice-President and Treasurer of the Midvale Steel and Ordnance Company, the subject being Relations between Employer and Employee.

John P. Mudd,
Secretary.

PROVIDENCE ENGINEERING SOCIETY

The Power Section held a meeting on January 7 in the rooms of the Society, at 8 p. m. E. L. Woolley, Assistant Superintendent of the Providence plant of the Bethlehem Shipbuilding Corporation, spoke on Work Accomplished at Providence for the Emergency Destroyer Program. Mr. Woolley's address was of singular interest to members of the profession, informed for the first time of the splendid engineering achievements which of necessity were not generally known during the war.

W. A. Kennedy,
Secretary.

WASHINGTON, D. C.

An organization meeting of the members residing in the District of Columbia was held on December 9. An informal dinner was followed by a meeting at the Interior Building, which was addressed by Secretary Rice, Spencer Miller, the Council's official representative to the occasion, Dr. Stratton, Director of the Bureau of Standards, who spoke on the work of the bureau during the war, and Major O. B. Zimmerman, who read a paper on the new fuel.

At the January meeting this petition was presented to the Council, with the approval of the Committee on Local Sections, and the following Executive Committee authorized: Dr. S. W. Stratton, Chairman, George A. Weschler, Secretary, H. L. Whittemore, Arthur E. Johnson, J. K. Klinck.

Meetings of Student Branches

Now that the colleges are returning to normal conditions and the period of demobilization is taking place, Student Branch activities are being resumed. The following meetings have been held:

BUCKNELL UNIVERSITY

November 4, 1918. A business meeting was held at which the following officers were elected for the Student Branch: Prof. B. F. Burpee, honorary chairman; R. C. Corrulla, chairman and C. W. Withington, secretary.

Mr. R. C. Corrula gave a very interesting talk, after which the senior mechanical engineering students decided to attend the Annual Meeting of the A.S.M.E. to be held in New York.

Prof. F. E. Burpee gave a brief talk, which was followed by a social gathering.

January 6. Plans were made for a reception and dance to be given by the Student Branch later in the year, and also an illustrated lecture to be given during the month of January.

Mr. H. R. Pars gave a brief talk on the Annual Meeting of the A.S.M.E. in New York and the inspection trip taken by the students of Bucknell who attended the Annual Meeting.

Clyde W. Withington,
Branch Secretary.

JOHNS HOPKINS UNIVERSITY

The following officers were elected for the Student Branch, year 1918-19: Prof. A. G. Christie, honorary chairman; W. D. Cook, chairman; H. Bloomsburg, vice-chairman, and H. E. Weaver, secretary-treasurer.

Harry E. Weaver,
Branch Secretary-Treasurer.

LEHIGH UNIVERSITY

The following officers were elected for the Student Branch, year 1918-19; Prof. P. B. de Schweinitz, honorary chairman; B. P. Lauder, chairman; C. T. Hunt, secretary, and C. D. Mertz, treasurer.

P. B. de Schweinitz,
Branch Honorary Chairman.

LELAND STANFORD, JR., UNIVERSITY

November 12, 1918. Several meetings had been planned for earlier in the semester, but due to the introduction of the Students Army Training Corps into the University, the meetings had to be postponed until finally the above mentioned successful meeting was held.

The following officers were elected: Prof. W. F. Durand, honorary chairman; Chever Kellogg, chairman, and C. D. Howe, secretary-treasurer. President Kellogg then conducted the remainder of the meeting, on topics concerning the welfare of our Society.

C. D. Howe,
Branch Secretary-Treasurer.

UNIVERSITY OF MICHIGAN

The following officers were elected for the Student Branch, year 1918-19: Prof. J. E. Emswiler, honorary chairman; D. M. Ferris, chairman; J. T. Huette, vice-chairman, and A. D. Althouse, secretary-treasurer.

J. E. Emswiler,
Branch Honorary Chairman.

UNIVERSITY OF MINNESOTA

The following officers were elected for the Student Branch, year 1918-19: Prof. J. J. Flather, honorary chairman; George W. Bierman, chairman; H. B. Abrahamson, vice-chairman; Ross M. Foltz, secretary; Milton S. Wunderlich, corresponding secretary, and Arthur Baker, treasurer.

J. J. Flather,
Branch Honorary Chairman.

UNIVERSITY OF MISSOURI

The following officers were elected for the Student Branch, year 1918-19: Prof. H. Wade Hibbard, honorary chairman; Will Copher, chairman, and K. K. King, secretary.

H. Wade Hibbard,
Branch Honorary Chairman.

UNIVERSITY OF NEBRASKA

The following officers were elected for the Student Branch, year 1918-19: Prof. L. F. Seaton, honorary chairman; V. E. Kauffman, chairman; W. L. Miller, vice-chairman, and H. M. Glebe, treasurer.

L. F. Seaton,
Branch Honorary Chairman.

NEW YORK UNIVERSITY

The following officers were elected for the Student Branch, year 1918-19: E. McCarthy, chairman; W. W. Damm, vice-chairman; A. A. Landi, secretary, and T. Tottis, treasurer.

A. A. Landi,
Branch Secretary.

OHIO STATE UNIVERSITY

The following officers were elected for the Student Branch, year 1918-19: Prof. Wm. T. Magruder, honorary chairman; Franklin H. Cover, chairman; Howard Orth, secretary, and Victor L. Dannell, treasurer.

Wm. T. Magruder,
Branch Honorary Chairman.

PENNSYLVANIA STATE COLLEGE

Three meetings have been held by the Student Branch since the college year opened, the first two being business meetings at which plans were discussed for carrying on the activities for the year, and the following officers were elected: Prof. J. O. Keller, honorary

chairman; H. W. Parthemer, chairman; I. A. Karam, vice-chairman; C. W. Moore, secretary; R. H. Schmidt, corresponding secretary, and R. Y. Sigworth, treasurer. At the third meeting Professor Fessenden gave a very excellent talk on Motor Transport Service.

R. H. Schmidt,
Branch Corresponding Secretary.

POLYTECHNIC INSTITUTE OF BROOKLYN

November 1, 1918. The first meeting of the Student Branch was very well attended owing to the fact that a great many of the S. A. T. C. students were excused from evening study to attend the meeting. Professor E. W. Church delivered a talk on Submarine Construction in which he told of the various types of submarines and the distinguishing features of each type.

Professor W. D. Ennis, formerly Major in the U. S. Ordnance Department, gave a talk on The Gun as a Gas Engine. He also explained the structure of powder and compared the energy produced by a gun to that produced by a gas engine.

The following officers were elected for the Student Branch: Nathan N. Wolpert, chairman; J. P. Minotty, vice-chairman; Ben Offen, treasurer; M. J. D'Aiello, secretary.

Nathan N. Wolpert,
Branch Chairman.

RENSSELAER POLYTECHNIC INSTITUTE

The following officers were elected for the Student Branch, year 1918-19: Prof. Arthur M. Greene, Jr., honorary chairman; R. I. Todd, chairman; J. M. Dewey, vice-president; C. G. Bragaw, secretary, and J. L. Smith, treasurer.

A. M. Greene, Jr.,
Branch Honorary Chairman.

STATE UNIVERSITY OF IOWA

The following officers were elected for the Student Branch, year 1918-19: Prof. S. M. Woodward, honorary chairman; J. F. McLaughlin, chairman; W. J. Hohl, vice-chairman, and I. C. Jones, secretary-treasurer.

S. M. Woodward,
Branch Honorary Chairman.

THROOP COLLEGE OF TECHNOLOGY

November 20, 1918. A business meeting was held at which the following officers were elected: Prof. W. H. Adams, honorary chairman; Donald D. Smith, chairman; R. T. Knapp, vice-chairman; Roscoe R. Rockafield, secretary, and L. Erb, treasurer.

Roscoe R. Rockafield,
Branch Secretary.

WASHINGTON UNIVERSITY

The following officers were elected for the Student Branch, year 1918-19: Prof. E. L. Ohle, honorary chairman; Sidney Weiss, chairman; Herbert A. Strain, vice-chairman; Wm. J. Anderson, Jr., secretary, and Donald B. Baker, treasurer.

Wm. J. Anderson, Jr.,
Branch Secretary.

UNIVERSITY OF WASHINGTON

The following officers were elected for the Student Branch, year 1918-19: Prof. E. O. Eastwood, honorary chairman; Fairman B. Lee, chairman; C. P. Rummel, vice-chairman; E. E. Bissett, secretary, and Lester R. McLeod, treasurer.

E. O. Eastwood,
Branch Honorary Chairman.

WORCESTER POLYTECHNIC INSTITUTE

The following officers were elected for the Student Branch, year 1918-19: Prof. W. W. Bird, honorary chairman; Raymond B. Heath, chairman; Robert A. Peterson, vice-chairman; Stanley N. McCaslin, secretary; Thos. H. Ewing, treasurer, and Prof. H. P. Fairfield, corresponding secretary.

H. P. Fairfield,
Branch Corresponding Secretary.

YALE UNIVERSITY

The following officers were elected for the Student Branch, year 1918-19: Prof. L. P. Breckenridge, honorary chairman; J. V. Jenks, chairman, and W. L. Austin, Jr., secretary-treasurer.

L. P. Breckenridge,
Branch Honorary Chairman.

CONTROL OF BOILER OPERATION

(Concluded from page 141)

to determine where the loss due to a definite increase in CO will overbalance the gain from an increase in CO_2 making the CO probable.

Assuming, for example, that under the furnace and fuel conditions existing when Tests A and B were made 14 per cent was the safe limit for CO_2 for complete combustion, how much CO will it take to overbalance the benefit of raising the CO_2 to 16 per cent, assuming $T - t = 450$ deg.?

Applying Formula [4], it is found that there is a gain of $\left[\left(0.24 + \frac{58.46}{14}\right) - \left(0.24 + \frac{58.46}{16}\right)\right] \times 450 = 234$ B.t.u., and Formula [7] shows that this gain would be overbalanced by $10{,}150 \times \frac{P_c}{16 + P_c} = 234$, from which $P_c = 0.38$ per cent. Therefore, if the increase of CO_2 from 14 to 16 per cent cannot be accomplished without at the same time increasing the percentage of CO by 0.38 per cent, there is no gain in heat to the boiler.

But since there is no definite relation between the percentage of CO_2 and CO, it follows that within proper limits, depending on the construction of furnace, method of stoking, kind of fuel, air control, etc., maximum CO_2 can be attained without appreciable amounts of CO if the fireman exercises proper care and judgment. What these limits are must be ascertained by experiment for each plant, and if the construction of furnace and method of stoking vary appreciably it may be necessary to determine the maximum economic percentage of CO_2 for each boiler. But such determination is of small avail unless the firemen are properly instructed how to get maximum CO_2 with a negligible percentage of CO and have continuously brought to their attention the percentage of CO_2 they are getting.

THE PATENT SITUATION IN THE U. S.

(Concluded from page 149)

Addendum

To the Editor:

Since the action of the National Research Council and of the Engineering Council approving and adopting the report of the Patent Committee of the National Research Council, at which time the report bore the unqualified approval of the Hon. James T. Newton, Commissioner of Patents, Mr. Newton has written me as follows:

January 21, 1919.

Mr. E. J. Prindle,
The Trinity Building,
111 Broadway,
New York, N. Y.

Dear Mr. Prindle:

Regarding the report of the Patent Committee, after careful consideration I have concluded it best to withdraw my approval of that part of the report concerning the separation of the Patent Office from the Interior Department.

I hope we will all exert ourselves for the passage of these statutes in proportion to the importance of the subject.

With best wishes, I am,
Sincerely,
(Signed) J. T. Newton,
Commissioner.

As Mr. Newton gives no reasons for this action, and as he does not state that he disapproves of this feature of the report, I infer that his action is taken because he considers that he cannot, with good grace, advocate a separation from the Interior Department while he is an official of that department.

Edwin J. Prindle.

January 23, 1919.

A Society pin was found some time ago in the railroad depot in Bridgeport, Conn., and forwarded to the New York headquarters of the Society, where it is being held awaiting the owner.

NECROLOGY

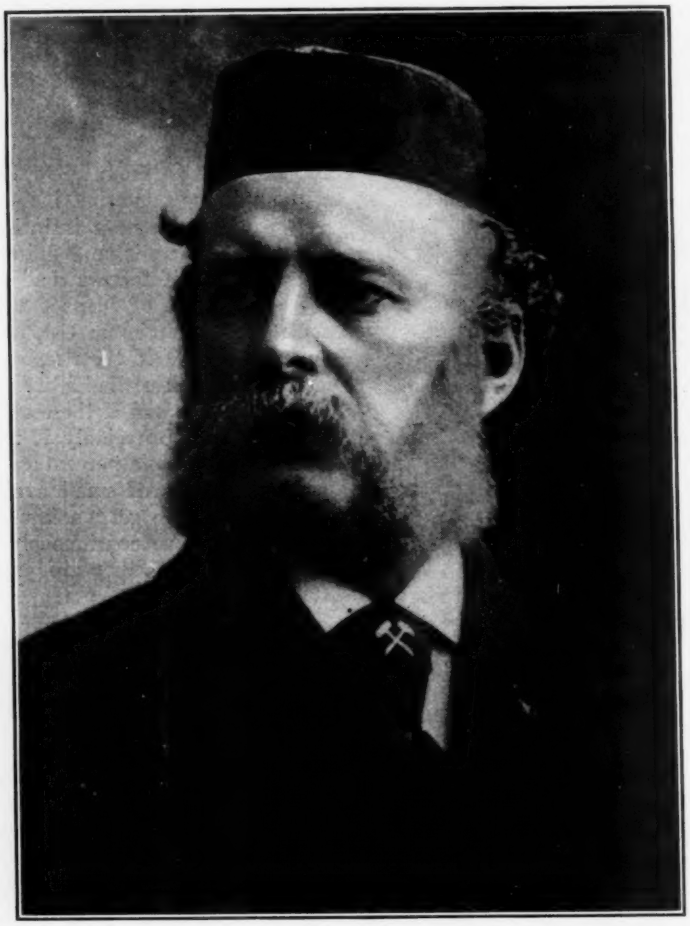
ROSSITER WORTHINGTON RAYMOND

Dr. Rossiter Worthington Raymond, mining engineer, metallurgist, lawyer and author, and for 25 years previous to 1912 the Secretary of the American Institute of Mining Engineers, died suddenly from heart trouble on December 31, at his home in Brooklyn, N. Y. He was born in Cincinnati, Ohio, April 27, 1840. He received his early education in the public schools of Syracuse, N. Y., and later attended the Brooklyn Polytechnic Institute, from which he graduated at the head of his class in 1858. He spent the ensuing three years in study at the Royal Mining Academy, Freiberg, Saxony, and at the Heidelberg and Munich Universities.

Returning to the United States in 1861, he entered the Federal Army and served as aide-de-camp, with the rank of captain, on the staff of Maj.-Gen. J. C. Fremont, by whom, during his campaign in the valley of Virginia, he was officially commended for gallant and meritorious conduct.

From 1864 to 1868 he engaged in practice as a consulting mining engineer and metallurgist in New York City, and in the latter year was appointed United States Commissioner of Mining Statistics, which position he held until 1876, issuing each year "Reports on the Mineral Resources of the United States West of the Rocky Mountains." In 1870 he was appointed lecturer on economic geology at Lafayette College, which chair he occupied until 1882. In 1873, Dr. Raymond was appointed United States Commissioner to the Vienna International Exposition, and as such delivered at Vienna addresses in the German language at the International Meeting of Geologists; and an address in English at the meeting of the Iron and Steel Institute at Liège, Belgium.

From 1875 to 1895 he was associated, as consulting engineer, with the firm of Cooper & Hewitt, owners of the New Jersey Steel & Iron Co., the Trenton Iron Co., the Durham and the Ringwood Iron Works, as well as numerous mines of iron ore and coal. As president of the Alliance Coal Co. and director of the Lehigh & Wilkes-Barre Coal Co., as well as a personal friend of Franklin B. Gowan, he became acquainted with the inner history of the memorable campaign against the "Molly Maguires," and has since been known as a fearless opponent of all tyranny practiced in the name of labor. His articles on "Labor and Law," "Labor and Liberty," etc., published in the *Engineering and Mining Journal* at the time of the Homestead riots, attracted wide attention, and for these, as well as similarly frank discussions of the operations of the Western Federation of Miners in Montana, Idaho and Colorado, he received special denunciations and threats from the labor unions thus criticised.



DR. ROSSITER W. RAYMOND

While connected with Cooper & Hewitt, he assisted Abram S. Hewitt in the management of Cooper Union and for many years directed the Saturday Evening Free Popular Lectures on Science, etc., which constituted the beginning of the present vast lecture system in New York City.

From 1885 to 1889, he was one of the three New York State Commissioners of Electric Subways for the City of Brooklyn, and served as member and secretary of the board. At the close of his official term as commissioner, he became consulting engineer to the New York & New Jersey Telephone Co.

In 1898, Dr. Raymond was admitted to the bar of the Supreme Court of New York State, and of the Federal District and Circuit Courts, his practice being confined to cases involving either mining or patent law, in the former of which he was a leading authority. In 1903, he was lecturer on mining law at Columbia University, New York.

He was an original member of the American Institute of Mining Engineers and served as its vice-president in 1871, 1876 and 1877; and as president from 1872 to 1875. While secretary of the Institute he edited the annual volumes of Transactions in a manner so painstaking and thorough, and with so high a degree of scholarship, that they were universally recognized as models of what such publications should be. To these he contributed many essays, especially pertaining to the United States mining laws, as well as other articles of importance. He was editor of the *American Journal of Mining* from 1867 to 1868, of the same periodical under the title *Engineering and Mining Journal* from 1868 to 1890, and continued thereafter a special contributor to that journal. In 1884 he prepared for the United States Geological Survey an historical sketch of mining law which was subsequently translated into German and published in full by the *Zeitschrift für Bergrecht*, the only periodical in the world devoted exclusively to the subject of mining jurisprudence.

In 1911, during the visit to Japan of a party of members and guests of the American Institute of Mining Engineers, Dr. Raymond received from the Mikado the distinction of Chevalier of the Order of the Rising Sun—fourth class, the highest ever given to foreigners not of royal blood—"for eminent services to the mining industry of Japan." These services consisted in advice and assistance rendered in America to Japanese engineers, students and officials throughout a period of more than twenty-five years.

In 1912, he resigned his position as secretary of the American Institute of Mining Engineers, of which he has been since that time secretary emeritus.

Dr. Raymond was an honorary member of the American Association for the Advancement of Science, the American Philosophical Society, the Society of Civil Engineers of France, the Iron and Steel Institute and the Institution of Mining and Metallurgy of Great Britain, the Canadian Mining Institute, the Mining Society of Nova Scotia, the Australasian Institute of Mining Engineers, and the Military Orders of the Loyal Legion of the United States; he as a member of the National Geographic Society, and a life member of the American Geographical Society. He received the degree of Ph.D. from Lafayette College in 1868, and that of LL.D. from Lehigh University in 1906 and from the University of Pittsburgh in 1915.

Besides the literary work already mentioned, Dr. Raymond prepared many other technical works and papers and was the author of a considerable number of books on general subjects, some in lighter vein and several of them for children. His writings to a remarkable degree were characterized by grace of expression, combined with clearness and unity, and his work bore ample evidence of the precision and accuracy of his scientific mind.

He married in Brooklyn, N. Y., March 3, 1863, Sarah Mellen Dwight of that city. He is survived by Mrs. Raymond and a daughter, Mrs. H. P. Bellinger of Syracuse, N. Y.

GAIL H. BROWNE

Gail H. Browne was born on March 12, 1871, in Salem, New York. He was educated in the public and high schools of Chicago, attending also the Chicago Medical College. He also spent two years in the Dental and Medical College of Northwestern University.

He spent the first five years after leaving college as surveyor and draftsman with the Chicago and North Western Railway and then with the International Harvester Co., and Swift & Co., at Chicago. In 1897 he became U. S. inspector of pier work and dredging in the Grand Rapids district. After one year in this district he became engineer in charge of the civil engineering department, McCormick division of the International Harvester Co. In 1905 he was employed by Ford, Bacon and Davis, engineers, New York. Since that time he has been actively engaged by this firm on important design and construction work, principally at Chicago, Memphis, New Orleans, Allentown, Pa. and in the New York office.

Mr. Browne died at his home in Glen Ridge, N. J., on December 7, 1918. He was a member of the Louisiana Engineering Society. He became a member of our Society in 1916.

ALFRED BETTS

Alfred Betts was born on October 1, 1835, in Wilmington, Del., and was educated at the Friends' School there. He served his apprenticeship with the firm of Pusey, Jones & Betts, Wilmington, afterwards becoming a member of the firm. He was a partner in the firm of E. & A. Betts, manufacturers of machine tools, and later became president of the Betts Machine Co., until his retirement in 1889. He was a member of the Board of Water Commissioners of Wilmington for six years.

Mr. Betts died on Dec. 1, 1918. He became a member of the Society in 1881.

PATRICK JOSEPH BEAKEY

Patrick J. Beakey was born in Glann, Ennistymon, County Clare, Ireland, on July 16, 1881, and was educated there in the Christian Brothers' School.

He came to the United States in 1900 and worked as a machinist for the P. & F. Corbin Co., New Britain, Conn., and for the Pratt & Whitney Co., Hartford, Conn. He was employed in 1903 by the Underwood Typewriter Co., also in Hartford, to build special machinery. In 1908 he joined the tool-making force of the Royal Typewriter Co. and was in a short time promoted to the foremanship of the type department. In this position he assisted in the development and production of typemaking machinery and tools, and designed and

PATRICK J. BEAKEY

produced several styles of typewriter type. At the time of his death, Mr. Beakey was holding this position.

Mr. Beakey died on October 24, 1918, of Spanish influenza. He became an associate member of the Society in 1915.

CHARLES MUNROE BURGESS

Charles M. Burgess was born in 1843 in Michigan. He served his apprenticeship with his father, a manufacturer of machinery in Windsor Locks, Conn. For about seven years he worked in the U. S. Armory at Springfield, Mass., and with the Collins Co., Collinsville, Conn., obtaining valuable shop experience. In 1866 he became associated with the Aetna Cutlery Works, New Britain, Conn., and about a year later entered the employ of Russell & Erwin as tool maker and was promoted shortly to foreman of the machine shops and in 1879 to the position of superintendent. In 1898 he retired from active business life.

Mr. Burgess was a member of Company C, 25th Regiment, Connecticut Volunteer Infantry, during the Civil War. He died on September 27, 1918. He became a life member of the Society in 1897.

MURRAY COPES CONLEY

Murray C. Conley was born on December 30, 1889, in Lamar, Mo., and was educated in the public schools of Wichita, Kan. He was graduated from the University of Kansas in 1909 and the following year took a post-graduate course in efficiency engineering.

His first position was with the Dewey Port Cement Co., Dewey, Okla., where he installed the cost system, assisted in laying out and had charge of the construction of a pulverized-coal mill of 100 tons capacity. In September 1913 he became connected with the McEwen Manufacturing Co., Tulsa, Okla., where he assisted in the installation of the Taylor system of scientific management, later having charge of the design and testing on an experimental series of reversing gas engines. His next position was with the Carter Oil Co., Tulsa, where he was employed in laying out walls for tank forms. In Ocober, 1915, he became associated with the Pitcher Lead Co., Joplin, Mo., where he supervised the reconstruction of one of their small lead smelters and the construction of a new lead smelter at Galena, Kan. Later he had charge of the construction of a large zinc-ore smelter at Henryetta, Okla. In June, 1916, he took a position with the

CHARLES MUNROE BURGESS

Henry L. Doherty Co., New York City, here he was employed in developing the process of pumping crude oils from the Kansas wells. Later he was assigned to one of the subsidiary companies, the Lorain County Electric Co. and was construction engineer on a large electric power plant at Lorain, Ohio, which position he held at the time of his death, December 21, 1918.

Mr. Conley became an associate member of the Society in 1917.

GEORGE DINKEL

George Dinkel, a member of the Society since 1890, was killed in an automobile accident near Havana, Cuba, on January 21.

Mr. Dinkel was born on November 28, 1866. He was graduated from Stevens Institute of Technology, Hoboken, N. J., in 1888, when he became associated with the American Sugar Refining Company as assistant manager at the Jersey City plant. At the time of his death he was chief engineer of the company, having been in its employ for 31 years.

He attained distinction in his profession, and was well known in the sugar industry. He had been granted a number of patents for important inventions, especially in the line of machinery for the refining of sugar.

Mr. Dinkel was also a member of the Engineers' Club of New York, and a member of the Board of Trustees of Stevens Institute of Technology.

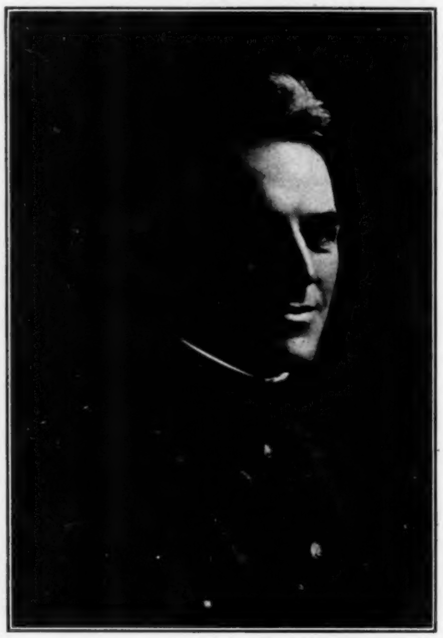
FRANK CAZENOVE JONES

Frank C. Jones was born in Washington, D. C., on June 14, 1857. He was graduated from the University of Virginia and then attended Stevens Institute of Technology where he received his M. E. degree. His first two years upon graduation were spent with the Baldwin Locomotive Works. In 1879 he became connected with the Delaware Bridge Co., and was next employed as mechanical expert and superintendent of factories for the New York Belting & Packing Co. Somewhat later he became manager of the International Okonite Co. For a number of years he was also president of the W. A. Underhill Brick Co., New York. Mr. Jones organized the Manhattan Rubber Manufacturing Co. in 1893 and was president of this company for ten years at which time ill health compelled his retirement from active work. At the time of his death, September 19, 1918, he was a director of the Lubricating Oil Co., and chairman of the Okonite Co., New York. Mr. Jones became a member of the Society in 1891.

LIEUT.-COLONEL FRANK J. DUFFY

Frank J. Duffy, Lieutenant-Colonel, 103rd Engineers, U. S. Army, was killed in France on August 18, 1918. Colonel Duffy and motorcycle driver were travelling from one part of the American line to another in a motorcycle. A German shell struck alongside of the machine and both were killed.

Colonel Duffy was born on August 27, 1884, in Scranton, Pa., and was educated there. He served his apprenticeship with the Scranton Railway Co., and was then connected for a short period with a firm of electrical contractors in Scranton on telephone, signal work and motor installation in factories. In 1904 he entered the engineering department of the Bell Telephone Co., Scranton, and a year later took a position with the Delaware & Lackawanna Railroad Co., where he had charge of the electrical installation of the Keyser Valley car



FRANK J. DUFFY

shops. From 1906 to 1909 he was in charge of the electrical department, Buffalo division, of the company, later being responsible for all the electrical work of the mining department, in Scranton, Pa.

When the United States entered the war Colonel Duffy was a leader in organizing the second company of engineers. He was named as Major and placed in charge of a battalion. While the 103rd regiment was in camp in Georgia Major Duffy was advanced to the rank of lieutenant-colonel.

Colonel Duffy was widely known in electrical circles throughout the country and was considered one of the foremost authorities in that industry. He was a member of the American Institute of Electrical Engineers, and of the Scranton Engineers' Club of which he was president. He became a member of our Society in 1917.

CLAUDE P. HAYNES

Claude P. Haynes was born in Ellsworth, Litchfield Co., Conn., on September 3, 1888. He attended the Rochester Mechanics' Institute for three years and later entered Syracuse University, taking the regular mechanical engineering course.

He served his apprenticeship as machinist with the General Electric Co., West Lynn, Mass., and was next with the American Optical Co., Southbridge, Mass., as draftsman. He held positions with the General Electric Co., Erie, Pa., where he designed the tools for a 175-hp. 8-cylinder gasoline motor; with the A. G. Gilman Printing Co., as chief engineer, designing two large rotary presses, folding and paper-handling machinery; with the Aetna Chemical Co., Pittsburgh, Pa., the Trantn Manufacturing Co., in the same city, as engineer salesman on power and power-transmission machinery; with the Aluminum Castings Co., Buffalo, N. Y., as chief engineer of their Niagara plant, and with the Curtiss Aeroplane & Motor Corporation as production engineer.

At the time of his death, Oct. 4, 1918, Mr. Haynes was holding the position of engineer in the research division of the Chemical Warfare Seervice in Washington, D. C.

Mr. Haynes became a junior member of the Society in 1916.

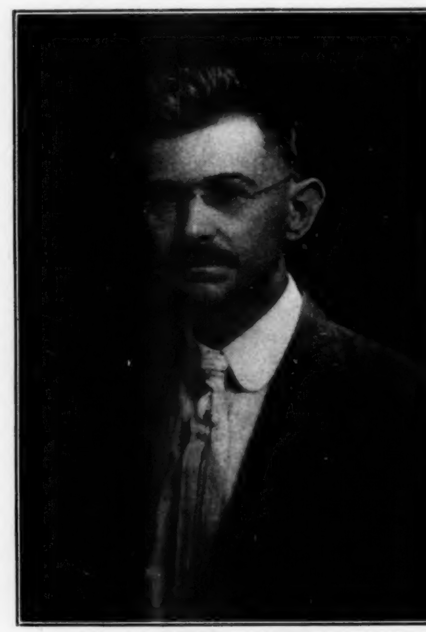
HENRY LOCKETT HUTSON

Henry Lockett Hutson was born at Americus, Ga., on December 30, 1876. He was the son of Charles Woodward Hutson and his wife, Mary Jane Lockett. His father was a college professor, occupying chairs in various southern colleges, including the University of Mississippi at Oxford, and the A. & M. College of Texas at Bryan.

Mr. Hutson received his preliminary education in the public and private schools in the towns where his family resided, and his college training at the A. & M. College of Texas, where he was graduated in the mechanical engineering course in 1896, one of the first three in his class. He exhibited unusual talent for mechanical work in his early childhood, and was a great student of engineering subjects up to the time of his death.

In 1898 he volunteered as a private in the First Regiment of the U. S. Volunteer Infantry, commanded by Colonel Riche. In 1898, after being mustered out, he entered the employ of Henry R. Worthington at the Brooklyn shops as a student apprentice and received the usual thorough training in practical hydraulic engineering given by the Worthington Company. In 1901 he entered the employ of A. M. Lockett & Co., Ltd., of New Orleans, as mechanical engineer. By reason of his ability and great loyalty to the interests of the company he was later promoted to the position of chief engineer.

In addition to engineering skill he possessed unusual talent in business management, and in addition to his work as chief engineer he was the sales manager and secretary of the Lockett Company. He supervised the designing and construction of perhaps a greater number of low-lift centrifugal pumping plants of large capacity than any other one engineer in this country, and by reason of this broad expe-



HENRY L. HUSTON

rience he was regarded as an authority on this class of work by other engineers in the Southwest.

Mr. Hutson became a member of the Society in 1906 and at the time of his death was Chairman of the New Orleans Section. He was also an active member of the Louisiana Engineering Society. He died on January 10, 1919.

OCTAVIUS AUGUSTUS LAW

Octavius A. Law was born on October 27, 1872, in Philadelphia, Pa., and received his education in the public schools of that city. He served his apprenticeship with William B. Smith, a general contractor of Philadelphia, later becoming his estimator, draftsman and foreman of erection of numerous public buildings. In 1899 he became connected with the Midvale Steel Co., Philadelphia, as assistant to the chief engineer and had entire charge of all furnace and building construction. He was with this company at the time of his death, October 26, 1918.

Mr. Law became an associate of the Society in 1915.

LEO JULIUS LEFFLER

Leo J. Leffler was born on June 30, 1885, in New York City. He was educated in the public schools of Brooklyn, attending Manual Training High School and later Cornell University from which he was graduated in 1907 with the degree of M. E.

Upon graduation he entered the corporation of Chas. Leffler & Co., Brooklyn, manufacturers of machinery and dies for the manufacture of tin and sheet-metal ware. He assisted his father, Mr. Charles Leffler in the active management of the company. He was secretary of the firm and was holding this position at the time of his death.

Mr. Leffler died on December 20, 1918, in Albuquerque, N. M. He became an associate-member of the Society in 1915.

FRANK SHEPPARD LEISENRING

Frank S. Leisenring was born on January 18, 1887, in Northumberland, Pa. His family moved to Harrisburg, Pa., where he attended the public schools and later the Bordentown Military Academy, where he finished his preparation for Stevens Institute of Technology at the Stevens School, graduating from the latter in 1904. He then entered Stevens and was graduated with the class of 1908.

Upon graduation he entered the employ of the J. F. Shanley Co., contractors, Newark, N. J., and finally became their superintendent. He later went into the railroad supply business for himself under the name of the Mechanical Specialties Co., New York, holding the position of president. For five months after we entered the war he was engaged in inspecting wire for the Government at New Haven, Conn. The last year he devoted to engineering activities in the manufacture of airplanes for the United States Government.

In the latter part of 1917 Mr. Leisenring joined the 22d Regiment, New York State Guard, Company F. He later left Company F and organized a company of engineers, known as Company M, 22d Regiment, New York State Guard, and was connected with this company as Second Lieutenant.

Mr. Leisenring died on October 23, 1918, of pneumonia. He became an associate-member of the Society in 1917.

STEPHEN MINOT PITMAN

Stephen M. Pitman, vice-president of the Narragansett Mutual Fire Insurance Co., died at his home in Providence, R. I., on December 17, 1918.

Mr. Pitman was born in Boston, Mass., on July 19, 1850, and was educated in the public schools of that city. For a short period he attended Brown University, later going to Tufts College, where he received the degree of Ph. B. in 1869. Following his graduation from Tufts Mr. Pitman entered the Harvard School of Mining, receiving the degree of Mining Engineer in 1874, and afterwards went to Germany, where he pursued special studies in chemistry at the Universities of Heidelberg and Berlin. From 1877 to 1882 he was professor of chemistry at Tufts, at the close of that time becoming treasurer and general manager of the Butte Silver & Mining Copper Co., Butte, Mont. In 1886 he returned East as chemist and superintendent of the Valley Falls Co., Valley Falls, R. I. In 1888 he became general manager of the Copp Dyeing Co. He later became secretary of the Philadelphia Manufacturers' Mutual Fire Insurance Co., and was for a time connected with the Holmes Fibre Graphite Co., also of Philadelphia.

In 1894 he was elected secretary-treasurer of the Narragansett Mutual Fire Insurance Co., Providence, R. I., and remained in that capacity until he became vice-president, the office he was holding at the time of his death. He was also a director of the American Investment Co.

Mr. Pitman became an associate of the Society in 1892.

GEOFFREY LAWRENCE REID

Geoffrey L. Reid was born in Lawrence, Mass., on March 29, 1894. He was educated in the public schools of Lawrence and upon graduation from high school entered Massachusetts Institute of Technology, from which he was graduated in 1916 as a mechanical engineer.

His first position was with the General Electric Co., Lynn, Mass., in connection with cost work and estimating on Curtis steam turbines. He was next employed in the inspection department of the Associated Factory Mutual Co's., Boston, leaving that firm to enter the statistical department of the Stone & Webster Engineering Corporation, Boston. In December, 1917, he enlisted in the U. S. Naval Aviation Corps and was assigned as an inspector of aeroplane motors and stationed at the Curtiss Aeroplane & Motor Corporation, Buffalo, N. Y. In April, 1918, he received his honorable discharge from the Army owing to ill health.

Mr. Reid died on December 23, 1918. He became a junior member of the Society in 1916.

EDWIN H. ROUSSEAU

Edwin H. Rousseau was born in New Orleans, La., in September, 1884. He was graduated from the Louisiana State University in 1905 with the degrees of B. S. and M. E. He also attended Tulane University.

His first position was with the Central Electric & Improvement Co., Inc., New Orleans, where he was located for about four years. In 1910 he became manager of the order department and draftsman for the John H. Murphy Iron Works, also in New Orleans. Three years later Mr. Rousseau became connected with Dibert, Bancroft & Ross Co., Ltd., as a designer on multiple-effect evaporators, vacuum pans and barometric condensers, resigning in 1916 to take a position with the Dyer Co., Cleveland, Ohio, having charge of the cane-sugar department, handling all engineering incidental to building cane-sugar factories, etc. In the early part of 1917 Mr. Rousseau became assistant engineer in the engineering department of the E. B. Badger & Sons Co., Boston, Mass., where he had charge of the engineering work connected with the building of complete industrial and chemical plants.

Since October, 1917, Mr. Rousseau has been with the Birmingham Machine & Foundry Co., Birmingham, Ala., as chief engineer, which position he was holding at the time of his death, December 3, 1918.

Mr. Rousseau became a member of the Society in 1915. He was also a member of the Chemists' Club of New York and of the Civic Association of Birmingham.

ANGUS SINCLAIR

Angus Sinclair, D. E., founder and for the last 32 years editor-in-chief of *Railway and Locomotive Engineering*, died January 1, 1919,

Angus Sinclair

at his home in Milburn, N. J. He was born at Forfar, Scotland, and began his railroad career as a telegraph operator, gaining his engineering knowledge at the shops of the Scottish Northeastern Railway at Arbroath. After some service as a marine engineer he came to America and again took up railroading, first with the Erie and later as a locomotive engineer on the Burlington, Cedar Rapids and Northern. He attended the chemistry classes of the Iowa State University and was later appointed chemist on the railway, combined with the duties of roundhouse foreman. It was during this period that he first gave serious attention to the problem of fuel economy and smoke prevention. His methods, which met with considerable opposition at first, are now universally approved.

In 1883 he joined the editorial staff of the *American Machinist* and later became proprietor and editor of *Railway and Locomotive Engineering*. In a short time this paper became a leading authority in its field and has maintained its high character and standing ever since. Dr. Sinclair was the author of many popular books on engineering subjects. In 1908 he received the honorary degree of Doctor of Engineering from Purdue University. About this time he was also appointed special technical instructor in the mechanical department of the Erie Railroad. He traveled extensively in Europe as well as in America and was everywhere received as among the foremost authorities on all matters connected with the mechanical department of railways. He was closely identified with the work of many of the leading engineering societies in America and in Europe. He was elected a member of the American Railway Master Mechanics' Association in 1873. He served as secretary of the association from 1887 to 1896, was elected treasurer in 1900 and served continuously until the time of his death. He became a member of the Master Car Builders' Association in 1873. He was the first president of the New Jersey Automobile and Motor Club. He was a delegate to the International Railway Congress, held at Washington, D. C., St. Louis, Mo., and Berne, Switzerland.

Among the societies which he aided in establishing was the Traveling Engineers' Association, founded in his office in 1892. He was a Knight Templar in the Masonic fraternity, a governor in the St. Andrew's Society, ex-president of the Burns Society, besides being a member of the American Railway Guild, Lawyers' Club, New York Railway Club and numerous railway, Scottish and other societies.

Dr. Sinclair became a member of our Society in 1883.

CLARENCE B. D. UNVERFERTH

Clarence B. D. Unverferth was born on October 10, 1884, in Dayton, Ohio. He was educated in the parochial schools and in St. Mary's

College in Dayton, later taking a special course in hydraulic and steam engineering.

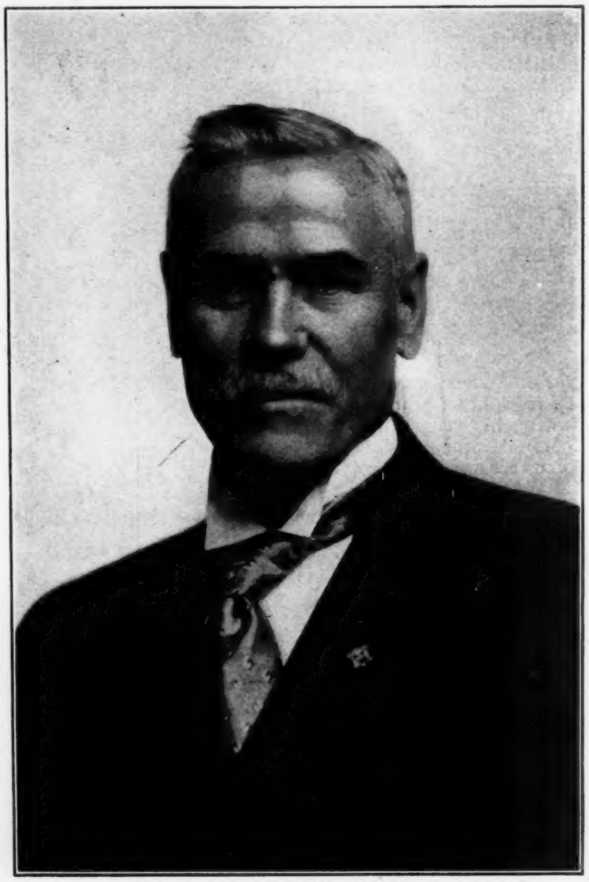
From 1902 to 1907 he was connected with the Platt Iron Works, Dayton, as draftsman on pumps, heaters, condensers and filter-press machinery. His next position was with the Dayton Hydraulic Machinery Co., as chief draftsman and designer on centrifugal pumps. He was with this company for three years, resigning to become designer and draftsman on paper-mill machinery and water wheels for the Dayton Globe Iron Works. In 1911 he became connected with the Ohmer Fare Register Co., Dayton, as tool designer, and the following year was with the Recording and Computing Machines Co., Dayton, as designer of tools and screw-machine cams. In 1913 he entered the office of the County Engineer of Montgomery County, Ohio, as chief draftsman and surveyor in charge of all drafting and field work. At the time of his death he was connected with the Aircraft Production Board at Dayton.

Mr. Unverferth died of pneumonia on November 10, 1918. He became an associate-member of our Society in 1918.

ROLLA C. CARPENTER

Prof. Rolla C. Carpenter, who has been a prominent member of the faculty of Sibley College, Cornell University, since 1890, died at his home at Ithaca, N. Y., on January 19.

The following account of Professor Carpenter's life is taken from that prepared only a few months ago for the *Sibley Journal of Engineering* at the time when he was about to retire from active service at the University, to devote his attention to engineering and consulting work, particularly along the lines of coke manufacture and the recovery of by-products incident to that industry. For many years Professor Carpenter was one of the most actively participating members of The American Society of Mechanical Engineers, a frequent attendant at meetings and one whom a very large number who came to the meetings always wanted to see and talk with.



Rolla C. Carpenter

Professor Carpenter was born near Orion, Michigan, June 26, 1852. His father, Charles K. Carpenter, owned an extensive farm at this place and was also vice-president of a railroad running between Detroit and Bay City, which now forms part of the Michigan Central system.

He graduated from Michigan Agricultural College in 1873 and received the degree of Civil Engineer from the University of Michigan in 1875. He was then engaged as an instructor in the Michigan Agricultural College, at the same time doing graduate work, and received the degree of Master of Science in 1876. In 1878 he was elected professor of mathematics and civil engineering at the Michigan Agricultural College, which position he held until 1890. During part of this period he spent his vacations, which then came in the winter months, studying at other institutions. Part of this time was spent at the Massachusetts Institute of Technology, where he studied under Professors Peabody and Lanza, and part was spent at Cornell, where he received the degree of Master of Mechanical Engineering in 1888. He was greatly assisted in the preparation of his thesis for the M.M.E. degree by his connection with the Lansing Iron and Engine Company of Lansing, Michigan, as consulting engineer. This connection placed at his disposal the facilities of a large and up-to-date manufacturing plant which offered opportunities not then enjoyed by any of the technical schools. This thesis, which is now on file in the University library and which was reported upon by Dr. Thurston in a paper read before The American Society of Mechanical Engineers, was on the subject of Internal Friction in Non-Condensing Engines and, as shown by Dr. Thurston's discussion, played an important part in the entire revision of the ideas which then prevailed concerning steam-engine friction.

In 1890 Professor Carpenter was elected Associate Professor of Engineering at Cornell University and the laboratory work was organized as a separate department under his direction. In 1895 he was elected professor of experimental engineering, which position he held up to the time of his death.

Professor Carpenter's experience in the several leading educational institutions as well as his intimate contact with various industrial enterprises peculiarly fitted him for the work of building up a course of instruction in experimental engineering which has done much for the upbuilding of the reputation of Sibley College and which is regarded by many alumni as furnishing a most valuable part of their education.

This system has been copied with some modifications in many other colleges and technical schools and has no doubt had a pronounced influence upon the methods of teaching other sciences.

Professor Carpenter published his "Notes on Mechanical Laboratory Practice" in 1891. This was the basis of his later text book on "Experimental Engineering" which has been the leading manual in this country on the subject. The first edition of his book on heating and ventilation was published in 1895 entitled "Heating and Ventilating Buildings." This book has gone through six revisions and has had an extensive circulation. It contains much original material from the author's own experience and is much quoted by later writers on heating and ventilating. Professor Carpenter is also joint author with Professor Diederichs of a textbook on "Gas Engines." In addition to these books, he has made many contributions to engineering literature through various societies and publications, among which may be mentioned The American Society of Mechanical Engineers, the American Society of Civil Engineers, and the American Society of Heating and Ventilating Engineers.

Professor Carpenter held membership in eight of the leading engineering societies of America. He was vice-president of The American Society of Mechanical Engineers from 1908 to 1911 and served on various committees of this Society, perhaps the most important of which is the Boiler Code Committee. He was President of the American Society of Heating and Ventilating Engineers in 1898, was vice-president of the American Society of Automobile Engineers in 1910-12, and has taken an active interest in the student branch of The American Society of Mechanical Engineers at Cornell.

Professor Carpenter engaged in a diversified field of investigation and research, including problems relating to power plants, gas engines, cement manufacture, coke manufacture, railway management, heating and ventilating, etc. He was one of the leading patent experts in the country and was employed by many of the leading law firms in various parts of the United States. He invented a number of pieces of laboratory apparatus, such as the Carpenter coal calorimeter, which was for many years a standard for testing the heating value of coal, the throttling and separating steam calorimeters now extensively used, a friction testing machine which may be found in most of the large laboratories and an inertia governor for the steam engine.

Professor Carpenter was honored by appointment to various positions of distinction. He was judge of machinery and transportation at the Chicago Exposition in 1893, at the Buffalo Exposition in 1901, and at the Jamestown Exposition in 1907. He was a member of the commission appointed by the Academy of Science in 1915 at the request of the President of the United States to investigate the slides at the Panama Canal and to make such recommendations as in the judgment of the commission would improve the conditions and lessen the possibilities of slides in the future. He received the degree of Doctor of Laws in 1907 from the Michigan Agricultural College.

Professor Carpenter's kindly manner and genial disposition made it easy for even the most timid to approach him and he was never too busy to be considerate of anyone who sought his council and advice. His large and varied experience, coupled with good judgment and his extensive knowledge of the engineering profession and of human nature, made his counsel and advice exceedingly valuable to his colleagues as well as to students and the world at large.

In a pamphlet on International Control of Minerals recently issued by the U. S. Geological Survey, the strategic position of the United States is graphically shown by a table compiled by Dr. C. K. Leith. The United States controls about one-third of the world's mineral production of 1,700,000,000 tons. The few minerals for which this country is dependent on foreign countries are offset by so many in which we have a dominance of supply and our financial position is so strong that it appears certain that in this respect our entrance into a league of nations would not be based on self-interest. The interests of conservation clearly require an international control of minerals. But this will depend on whether the nations are willing to make the necessary economic sacrifices in the interest of world harmony.

PERSONALS

IN these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary, and items should be received by February 15 in order to appear in the March issue.

CHANGES OF POSITION

ALEXANDER M. GRIER has become associated with the Combahee Company, White Hall, S. C., in the capacity of general manager. He was formerly sanitary engineer with the E. I. duPont de Nemours and Company, Wilmington, Del.

ARTHUR B. COATES has resigned his position with the Ford Motor Company, Detroit, Mich., in the power and construction department, and has accepted the position of assistant mechanical engineer with the U. S. Bureau of Mines, Pittsburgh, Pa.

PAUL BEEN has become affiliated with the Morgan Engineering Company, Alliance, Ohio, in the capacity of engineer. He was until recently connected with the Manierre Engineering and Machine Company, Milwaukee, Wis.

LEON E. JEANNERET, formerly connected with the Babcock and Wilcox Company, Bayonne, N. J., has become associated with the King Bridge Company, Cleveland, Ohio.

B. R. SAUSEN, formerly manager of the Chicago office of the Schutte and Koerting Company, has become identified with the Star Brass Works of the same city, engaged in sales promotion and research work of Spray cooling equipment.

FREDERICK A. SCHEFFLER, formerly connected with the New York offices of the Babcock and Wilcox Company, has become associated with the Fuller Engineering Company, of Allentown, Pa., as manager of the department devoted to the application and introduction of pulverized coal equipment for steam power plants in the United States. Mr. Scheffler's headquarters are in New York City.

ERNEST K. HILL, until recently connected with the Wright-Martin Aircraft Corporation, New Brunswick, N. J., in the capacity of assembly inspector has assumed the position of mechanical draftsman with the E. J. Longyear Company, Marquette, Mich.

W. JOCELYN DALE has resigned as superintendent of power for the Matahambre Copper Mines at Sta Lucia, Pinar del Rio, Cuba, to take the position of electrical engineer with the Elia Sugar Company, and engineer with the Cuba Cane Sugar Corporation, of Havana, Cuba.

RAY MAYHEW has severed his connections with the Minneapolis Steel and Machinery Company, Minneapolis, Minn., with whom he has been affiliated for ten years, and has accepted a position as motor engineer with the American Hoist and Derrick Company, St. Paul, Minn.

ROY A. WATKINS is no longer connected with the Bureau of Steam Engineering at Washington, D. C., having assumed the duties of vice-president and general manager of the Bath Machine Works, Inc., Bath, N. Y.

ANNOUNCEMENTS

N. L. SNOW, formerly vice-president and sales manager of the Terry Steam Turbine Company, Hartford, Conn., has been elected vice-president and general manager of that company. Mr. Snow has been connected with the company for the past ten years.

WILLIAM PATERSON has accepted a position with the Illinois Maintenance Company, Chicago, Ill.

LOUIS W. ADAMS has assumed the position of manager of the open hearth department of the Ashland Iron and Mining Company, Ashland, Ky.

HENRY FORD has resigned the presidency of the Ford Motor Company, Detroit, Mich., to devote his time to his new weekly newspaper, the *Dearborn Independent*, and his tractor plant at Dearborn, Mich.

FRANK D. BAKER, formerly in mechanical and mill design in Colorado and, since its organization in 1899, with the American Smelting and Refining Company, as chief engineer of the Colorado department, has retired. He will do limited mechanical consultant work in Denver, in association with his sons.

WALTER N. POLAKOV, consulting engineer, announces the founding of Walter N. Polakov and Company, Inc., New York, consultants in power-production methods, industrial investigations, labor problems, scientific-record systems and production accounting.

ALFRED MUSSO will have charge of the Coast Coaling and Engineering Company's newly-organized department for the development of labor-saving machinery. He will give special attention to questions pertaining to the handling of bulky materials, the coaling of ships and general stevedoring.

HERBERT B. REYNOLDS, formerly a fuel engineer in the U. S. Bureau of Mines, has returned to the motive power department of the Interborough Rapid Transit Company, of New York, as mechanical research engineer.

MORRIS L. COOKE, Boyd Fisher, KEPPELE HALL, HORACE K. HATHAWAY, Clyde L. King and John H. Williams, announce the opening of an office in Philadelphia, Pa., as consulting engineers in management.

M. L. KAUFMAN is a member of the recently established firm of Kaufman and Levine, consulting and industrial engineers, of New York. Mr. Kaufman was employed, for the last three and a half years, by J. H. Wallace and Company, pulp and paper engineers; recently, he was engineer on a section of the work at Nitro, W. Va., connected with the Cotton Purification Area, U. S. Explosives Plant "C."

LIEUT-COMMANDER FREDERICK L. PRYOR was presented, on December 21, with a gold watch by the released students at the demobilization of the Naval Section of the Students' Army Training Corps at Stevens Institute of Technology, Hoboken, N. J.

JAMES W. SMITH resigned, on January 1, as general superintendent of Gray and Davis, Inc., Cambridge, Mass.

CLELAND COLDWELL ROSS, formerly superintendent with the Coldwell Lawn Mower Company, of Newburgh, N. Y., has recently returned to that company as works manager after serving as a lieutenant in the Ordnance Department of the Army.

CHARLES T. MYERS, formerly production engineer of the Savage Arms Corporation, Utica, N. Y., has been appointed works engineer of the Utica plant, in complete charge of the operation and maintenance of the mechanical and electrical departments of the plant.

ROBERT E. NEWCOMB, superintendent of the Deane Works of the Worthington Pump and Machinery Corporation, Holyoke, Mass., was elected president of the New England Foundrymen's Association, at a meeting held in Boston, January 8.

GEORGE E. RANDLES, general manager of the Foote-Burt Company, Cleveland, Ohio, has resigned as director of the maintenance division of the Motor Transport Corps and has returned to his regular duties in Cleveland, from Washington, where he has been located for more than a year.

APPOINTMENTS

MELVIN B. NEWCOMB, formerly chief draftsman of the hydraulic department of the Wellman Seaver Morgan Company, Cleveland, Ohio, has been appointed chief engineer of the rubber machinery department at the Akron, Ohio, works of the same company.

LIBRARY NOTES AND BOOK REVIEWS

George Westinghouse

GEORGE WESTINGHOUSE. His Life and Achievements. By Francis E. Leupp. Little, Brown and Co., Boston, 1918. Cloth, 6 x 9 in., 304 pp., 5 pl., 6 portraits. $3.

George Westinghouse was a prominent figure in the industrial life not only of America, but of the world for so many years, that it was greatly to be desired that a suitable biography should be written for the satisfaction of his friends and admirers and for the instruction of the younger men in the industrial field.

He worked in so many lines, and with such splendid results, that a complete biography would cover the engineering and technical work which he did, as well as the administrative and business side of his career.

Mr. Leupp is an accomplished literary man, but not an engineer; and he undoubtedly felt that he could not with advantage discuss the technical side of Mr. Westinghouse's career. He disarms criticism by confessing frankly that the mission of his volume is simply human. It is a pleasure to say that within its limitations this biography of Mr. Westinghouse is quite complete and satisfactory. Indeed, it is a credit to Mr. Leupp's industry and investigation that he should have been able, with practically nothing in the shape of diaries or personal correspondence, and relying for the personal touch almost entirely on the memory of associates, to give such a true picture of the great and wonderful man about whom he was writing.

There are, of course, omissions which will occur to anyone who was at all intimate with Mr. Westinghouse and his interests, such, for example, as the absence of the name of Benjamin G. Lamme from the list of able assistants in the electrical field. By many he is regarded as the most striking figure, in the way of electrical genius, of these assistants.

Mr. Leupp stresses the well-known fact, among his intimates of Mr. Westinghouse's great confidence in his own judgment;

but it is not quite so clear as he might have made it that there was great justification for this confidence from the numerous cases in which Mr. Westinghouse had backed his own judgment against that of his advisors, and had proved to be right. The reviewer makes this remark because he once had occasion to discuss this very point with a critic of Mr. Westinghouse; and after explaining in detail a number of important and remarkable cases where his judgment had been proved correct, the critic agreed that it was not a cause for surprise that he should have trusted his own judgment more than that of any other person.

The financial difficulties through which the Electric Company passed led many careless observers to say that Mr. Westinghouse was no financier. Mr. Leupp tells the story of the difficulties, both in 1893 and 1907, and shows, to those who know, his appreciation of the fact that Mr. Westinghouse really was a great financier. It so happens that the reviewer, who was then an officer of the Electric Company, came into possession of information entirely independent of Mr. Westinghouse, through financial friends in Pittsburgh, which showed that the rehabilitation of the Electric Company in 1908 was due entirely to Mr. Westinghouse. The Committee of Bankers had advised a scheme which fell absolutely flat; and it was not until the so-called Merchandise-Creditors Plan was proposed that any success was attained. This plan was, in conception and detail, the work of Mr. Westinghouse. Doubtless this is a case of definition. If to be a financier means to sit in a marble palace, handling other people's money and making loans with ample security, refusing absolutely to take any chances whatever, then doubtless Mr. Westinghouse would not have laid any claim to being a financier. If, on the contrary, the courageous meeting of unusual difficulties with all the usually recognized financial authorities against you and success in the solution of the difficulties, is to be a financier, then he certainly was a great one.

It is a pleasure to note in Mr. Leupp's book that Mrs. Westinghouse receives considerable notice; and he shows her great executive ability as a hostess in the sympathetic story he tells. If he had known her intimately, he might have given additional touches showing her great sympathy and attention to all her guests, even the humblest; a trait which does not always accompany the executive capacity.

Mr. Leupp was evidently thoroughly in sympathy with, and a great admirer of, the wonderful man about whom he wrote, a condition which the writer believes absolutely necessary to a satisfactory biography; and the book can be confidently recommended to all who admire the story of a great life, full of wonderful deeds, and a benefit to humanity. As already stated, it is by no means a complete biography, because only the outstanding facts about his great works are given; and the engineering and technical side is almost entirely absent. It is to be hoped that before long the biography will be written by some competent engineer who is also an accomplished literary man, so that the complete story of the wonderful life of George Westinghouse may be preserved.

W. M. McFarland.

The A-B-C of Aviation. A complete, practical Treatise outlining clearly the Elements of Aeronautical Engineering with special reference to simplified Explanations of the Theory of Flight, Aerodynamics and Basic Principles underlying the Action of Balloons and Airplanes of all Types. A non-technical Manual for all Students of Aircraft. This book includes instructions for lining up and inspecting typical Airplanes before flight and also gives easily understood rules for flying. By Victor W. Page. The Norman W. Henley Publishing Co., New York, 1918. Cloth, 6 x 9 in., 274 pp., 128 illus., 7 pl. $2.50.

A companion volume to the author's Aviation Engines, giving a simple account of the operation and repair of airplanes. Intended for use by prospective aviators and mechanics, not as a treatise for engineers and designers.

Aerobatics. By H. Barber. Robert M. McBride and Co., New York, 1918. Cloth, 11 x 18 in., 61 pp., 29 pl. $3.

An explanation of the general rules governing flying. The instruction is arranged in progressive form and is intended to convert the novice into an expert pilot in the shortest possible time, with the greatest possible degree of safety to himself and his machine.

American Engineers Behind the Battle Lines in France. By Robert K. Tomlin, Jr. First edition. N. Y., published by *Engineering News-Record.* (McGraw-Hill Book Co., Inc., sole selling agents.) New York, 1918. ¼ cloth, 9 x 12 in., 91 pp., illus. $2.

These nineteen articles, reprinted from the McGraw-Hill periodicals of the year, describe various phases of the engineering work executed by the American Army. Gathered together, they form an interesting account of the problems and the methods used to solve them.

American Problems of Reconstruction. A National Symposium on the Economic and Financial Aspects. Edited by Elisha M. Friedman, with a Foreword by Franklin K. Lane. E. P. Dutton and Co., New York, 1918. Cloth, 5 x 8 in., 471 pp. $5.

The editor here presents the opinions of some twenty-eight prominent Americans in the hope of stimulating thought on the subject. The specific points treated are the temporary effects of the war, the best methods of facilitating our readjustment to peace conditions, the permanent effects of the war, the changes that these will effect in our national life, and the national economic policy that should be adopted.

Annual Chemical Directory of the United States. Second edition, 1918. Consulting Editor, B. F. Lovelace; Managing Editor, Charles C. Thomas. Williams and Wilkins Co., Baltimore. (copyright 1918). Cloth, 6 x 9 in., 534 pp. $5.

This directory is intended as a comprehensive review of all matters relating to industrial, technical and scientific chemical development in the United States. It contains lists, classified by subject and location, of manufacturers and dealers in chemicals and allied products and in equipment; a geographical directory of industrial, institutional, federal, state, municipal and commercial laboratories; a list of technical and scientific societies of the world, and bibliographies of technical and scientific journals, and of the important new books of 1917-1918. A "News and Notes" section completes the work. This second issue is approximately twice as large as the first.

The Atomic Weights of Boron and Fluorine. By Edgar F. Smith and Walter K. Van Haagen. Carnegie Institution, Washington, D. C. Paper, 7 x 10 in., 65 pp., 4 illus., 4 tab. $1.

The authors decribe in detail their work upon the atomic weight of boron and give a recalculation of that of fluorine, based upon their new value for boron. This latter value is considerably lower than that hitherto accepted.

Electric Motors and Control Systems. A Treatise on Electric Traction Motors and Their Control. By A. T. Dover. Sir Isaac Pitman and Sons, Ltd., London, 1918. Cloth, 6 x 9 in., 372 pp., 315 illus., 9 tab. $6.

In this volume, which is an amplification of a portion of his work on Electric Traction, the author treats of the application of electric motors to railways. The endeavor has been to meet the needs of engineers and advanced students of engineering, rather than those of specialists in electric railway equipment.

Electrical Equipment of the Motor Car. By David Penn Moreton and Darwin S. Hatch. U. P. C. Book Co., Inc., New York, 1918. Flexible cloth, 5 x 7 in., 506 pp., 428 illus. $2.50.

This work is intended to give the lay reader sufficient knowledge of the electrical equipment of an automobile to enable him to operate it intelligently and to make ordinary adjustments and repairs. It is compiled from a series of articles that appeared in *Motor Age,* with additions and emendations.

Electricity and Magnetism for Engineers. Part I. Electric and Magnetic Circuits. By Harold Pender. First edition. McGraw-Hill Book Co., Inc., New York, 1918. Cloth, 6 x 9 in., 380 pp., 98 illus. $3.

This volume covers substantially the same ground as that of the author's Principles of Electrical Engineering. The method of treatment, however, is distinctly different. The various laws and relations are more fully discussed and a greater number of practical applications are given. Particular emphasis is laid upon exact quantitative statements of the fundamental laws.

THE ENGINEERING INDEX

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DIVISIONS OF THE ENGINEERING INDEX

Mechanical Engineering

AIR MACHINERY

Turbo-Blowers

Coppus Turbo Blower. Indus. Management, vol. 57, no. 1. Jan. 1919, pp. 74-75, 2 figs. Mechanical features of machine constructed by Coppus Eng. & Equipment Co.

Combined Motor and Turbine Driven Blast-Furnace Blower. Iron & Coal Trades Rev., vol. 47, no. 2645, Nov. 8, 1918, p. 523, 1 fig. Operation of unit consisting of synchronous motor driving blower, this motor being operated in addition as a power-factor adjuster on a 3000-volt 50-cycle supply.

Ventilators

The Largest Round Ventilator in the World. Metal Worker, vol. 91, no. 1, Jan. 3, 1919, pp. 28-29, 3 figs. Details of special construction to withstand wind pressure and secure permanence and service.

CORROSION

Aircraft Parts

Corrosion Prevention on Aircraft Metal Parts, H. A. Gardner. Aviation, vol. 5, no. 9, Dec. 1, 1918, pp. 565. Quotes standard procedure of Navy Department for protection or iron, steel and aluminum aircraft parts.

Pipe

Investigation of Pipe Corrosion in Chicago Buildings, with Special Reference to Durability of Pipe Materials, Thomas J. Claffy. Mun. & County Eng., vol. 55, no. 6, Dec. 1918, pp. 208-210. Data secured from inspection of 63 buildings. Rating of cast iron, wrought iron and steel.

FORGING

Density of Steel

Does Forging Increase Specific Density of Steel? H. E. Doerr. Bul. Am. Inst. Min. Engrs., no. 145, Jan. 1919, pp. 79-81, 2 figs. Table of specific densities of ten ingots of basic open-hearth steel both before and after forging shows little or no change in density with steel initially free from cavities.

Drop Forging

Drop Forging in Automobile and Aircraft Work. Part VI. Automobile Engr., vol. 8, no. 120, Nov. 1918, pp. 328-331, 13 figs. Details of typical plant, with description of modern tools and methods.

Gun Forgings

Making Gun Forgings Under War Demands, E. C. Kreutzberg. Iron Trade Rev., vol. 63, no. 22, Nov. 28, 1918, pp. 1240-1242, 6 figs. General character of work done by Tacony Ordnance Corps., Philadelphia.

Operation

Recommendations for Economical Operation of Iron Works (Dispositions générales qui peuvent être recommandées dans les installations de forges), O. Duperron. Génie Civil, vol. 73, nos. 20 and 21, Nov. 16 and 23, 1918, pp. 387-389 and 404-407, 3 figs. Concerning regenerative devices, use of powdered fuel, continuousness of operation, use of compressed air. Plans of ideal modern smithy.

FOUNDRIES

Brass Melting

Melting Brass in a Rocking Electric Furnace, H. W. Gillett and A. E. Rhoads. Department of Interior, Bur. of Mines, Bul. 171, Min. Technology 23, 131 pp., 6 figs. Sets forth in detail possibilities and limitations of electric brass melting and compares various types of furnaces. Also Water & Gas Rev., vol. 29, no. 6, Dec. 1918, pp. 9-11.

Chaplets

Obtaining Best Results from Use of Chaplets, Ernest Schwartz. Foundry, vol. 47, no. 317, Jan. 1919, pp. 14-15, 14 figs. Removal or prevention of rust and precautions against excessive moisture essential to prevent blowholes; choosing types and sizes for various purposes.

Note.—The abbreviations used in indexing are as follows:
Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
New York (N. Y.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

Core Room

Core-Room of T. H. Symington Co., Rochester, Donald S. Barrows. Can. Foundryman, vol. 9, no. 12, Dec. 1918, pp. 296-299, 9 figs. Arrangement intended to provide good ventilation and lighting.

Efficiency in the Core Room, J. B. Conway. Am. Mach., vol. 50, no. 1, Jan. 2, 1919, pp. 11-14, 6 figs. Conclusions reached as result of investigation into conditions of efficiency and production in southern factory and remedies applied.

Cupola

Operation of a Cupola, William Lauten. Metal Trades, vol. 9, no. 11, Nov. 1918, pp. 461-463, 2 figs. Account of experiments with column charging.

Foundries

Continuous Two-Story Foundry Proves Economical, J. F. Ervin. Foundry, vol. 47, no. 317, Jan. 1919, pp. 40-42, 2 figs. States that extensive handling operations in modern foundry are most readily performed in building of multi-story design. From paper before Am. Foundrymen's Assn.

Unique Features of an Illinois Foundry, Charles Lundberg. Iron Age, vol. 102, no. 26, Dec. 26, 1918, pp. 1563-1569, 13 figs. Electric steel, gray iron and semi-steel departments; continuous operations with large production in small space; use of molding machines. Description of plant of Avery Co., Peoria, Ill.

Molding

How Gear Cases for Tractors Are Molded. Foundry, vol. 47, no. 317, Jan. 1919, pp. 2-5, 8 figs. Molding machines of large capacity and special core-room equipment are employed; special rigging for economies.

Patterns and Their Relation to Molding Problems, Joseph A. Shelly. Machy., vol. 25, no. 4, Dec. 1918, pp. 310-314, 12 figs. First of series of articles dealing with construction and application of patterns, including use of woodworking tools, art of joinery, and various methods of building patterns and core boxes.

Salvage Work

Reclaiming Wealth in the Foundry Yard, F. B. Hicks. Can. Foundryman, vol. 9, no. 12, Dec. 1918, pp. 302-303. Salvage work conducted by a superintendent of Sawyer-Massey works.

War Demands

Shell Need Found Foundries Ready. Iron Trade Rev., vol. 63, no. 22, Nov. 28, 1918, pp. 1229-1236, 15 figs. Methods developed in American foundries to meet increased demand of production.

See also ELECTRICAL ENGINEERING, Furnaces (Industrial Furnaces, Steel Furnaces).

FUELS AND FIRING

Blast-Furnace Gas

The Use of Blast-Furnace Gas for Heating Boilers and Metallurgical Apparatus (L'emploi du gaz pour le chauffage des chaudières et des appareils métallurgiques), H. Thiry. Génie Civil, vol. 73, no. 21, Nov. 23, 1918, pp. 401-404, 8 figs. Precautions necessary to insure successful operation of Cowper system. Abstract of discussion before South Wales Inst. Engrs. and Cleveland Inst. Engrs.

Briquetting

The Economy of Briquetting Small Coal, J. A. Yeadon. Trans. Instn. Min. Engrs., vol. 56, part 1, Nov. 1918, pp. 31-34 and (discussion) pp. 34-36. Considerations on conservation of coal and utilization of waste materials; advantages of briquetting; method of manufacture; rectangular and ovoid forms of briquets.

Chimney Design

Saving the Waste in the Chimney, Robert Sibley and Chas. H. Delany. Jl. Elec., vol. 41, nos. 10 and 11, Nov. 15 and Dec. 1, 1918, pp. 463-464 and 511, 4 figs. Nov. 15: Fundamental laws of chimney design as applied to economic operation of oil-fired power plant. Dec. 1: Draft formula for modern power plant.

Combustion Characteristics of Coal

Combustion Characteristics of Coals. Blast Furnace, vol. 6, no. 12, Dec. 1918, pp. 495-497, 5 figs. Factors entering into success of equipment selected for burning different kinds of coal; performance of various types of stokers; data on grades of coal.

Generation of Heat from Bituminous Coal and Its Absorption by the Boiler, Henry Misostow. Power, vol. 48, no. 25, Dec. 17, 1918, pp. 898-899, 3 figs. From paper before National Assoc. of Stationary Engrs., Cincinnati, Sept. 1918.

Considerations and Practical Conclusions in Regard to the Combustion and Gasification of Carbon (Considerations diverses et conséquences pratiques au sujet de la combustion et de la gazéification du carbone), J. Seigle. Bulletin et Comptes rendus mensuels de la Société de l'Industrie Minérale, series 5, vol. 14, 3d issue 1918, pp. 79-112, 7 figs. Chemical and thermodynamic equations. Air is considered as $O_2 + 4N_2$. Examination of changes and combinations in coke gas producers.

Combustion Characteristics of Coal, Joseph G. Worker. Ry. Rev., vol. 63, no. 23, Dec. 7, 1918, pp. 824-827. Behavior of different grades of stationary boiler plant fuel with reference to type of mechanical stoking apparatus best suited for it. Fuels treated range from small sizes of anthracite through several grades and qualities of bituminous and lignites.

Combustion Characteristics of Coals and Selection of Suitable Stoker Equipment, Joseph G. Worker. Railroad Herald, vol. 23, no. 1, Dec. 1918, pp. 9-14, 7 figs. Results of tests on overfeed type of stoker with smaller sizes of nos. 1, 2 and 3 buckwheat coal and tables giving performance of underfeed stoker as applied to various sizes of boilers and burning different grades of coal.

Fuel Conservation

The Fuel Situation in New England, B. B. Pollock. Official Proc. N. Y. R. R. Club, vol. 29, no. 1, Dec. 1918, pp. 5455-5456. Measures taken to meet coal shortage by Federal Administrator, Boston & Maine R. R.

Some Important Points in Fuel Conservation, Robert Collett. Ry. Age, vol. 65, no. 25, Dec. 20, 1918, pp. 1121-1123. Why we must still save fuel; plan of organization; lessons learned from personal experience. From paper before New England Railroad Club.

Hand-Fired Plants

Fuel Economy in Hand-Fired Power Plants —V, Power Plant Eng., vol. 22, no. 24, Dec. 15, 1918, pp. 987-989. Feed water heating and purification. Abstract of circular 7, Univ. Ill. Eng. Experiment Station.

Indiana Coals

Burning Indiana Coal on the Chain Grate, T. A. Marsh. Power, vol. 49, no. 1, Jan. 7, 1919, pp. 17-19, 7 figs. Characteristics of Indiana screenings from four seams supplying most of steaming coal; need of large grate area, large furnace volume and strong draft to give capacity, and long, high-pitched arches.

Iowa Coals

Burning the Low-Grade Coal of Iowa, T. A. Marsh. Power, vol. 48, no. 27, Dec. 31, 1918, pp. 940-941, 4 figs. Burning Iowa coal on chain grate. Being low in heat value, high in ash and of clinkering, non-coking variety, this coal requires, for successful burning, practically continuous ash disposal and non-agitation of fire. Also Elec. World, vol. 72, no. 25, Dec. 21, 1918, pp. 1166-1168, 4 figs. General considerations to observe in selecting stokers and in designing furnaces; specific changes which can be made in order to adapt existing stokers to low-grade fuels.

Lignites

The Firing of Pulverized Lignite, M. C. Hatch. Jl. Elec., vol. 41, no. 12, Dec. 15, 1918, pp. 539-541. Advantages in pulverizing; methods of handling; furnace design for pulverized fuel; calculation of total cost.

Notes on Lignite, Its Characteristics and Utilization, S. M. Darling. Power House, vol. 11, no. 11, Nov. 1918, pp. 328-331. Abstract of U. S. Bureau of Mines paper.

Powdered Coal

Pulverized Coal and Its Preparation, J. M. Wadsworth. Jl. Elec., vol. 41, no. 11, Dec. 1, 1918, pp. 511-512, 2 figs. Arrangement of machinery in small coal pulverizing plant. Compiled for Western needs by technical staff of Fuel Administration. First of series.

Stokers

Power Plant Management VI Mechanical Stokers, Robert June. Refrig. World, vol. 53, no. 12, Dec. 1918, pp. 23-25, 3 figs. Efficiency of stokers; smoke alleviation; characteristics of individual chain-grate stokers.

Storage

Effect of Storage on Coal (II), Coal Trade Jl., year 50, no. 51, Dec. 1918, pp. 1481-1482. Analytical data accumulated during weathering tests made by Eng. Experiment Station of Univ. of Ill. Tests covered period of six years. Coals used were from Illinois field. (Continuation of serial.)

Wood

Waste Wood as a Fuel Possibility, O. F. Stafford. Jl. Elec., vol. 41, no. 12, Dec. 15, 1918, pp. 541-543. Suggests conversion of wood waste into ethyl alcohol, direct fuel and powdered charcoal which might be used directly in specially designed Diesel engine.

FURNACES

Annealing Furnaces

Continuous Type Annealing Furance, Philip d'H. Dressler. Iron Trade Rev., vol. 63, no. 25, Dec. 19, 1918, pp. 1416-1417, 5 figs. Deals specially with a form of continuous car-type annealing furnace. Discussion of H. E. Diller's paper before Am. Foundrymen's Assn.

Heat Treating

Equipment Data on Heat Treat Furnaces, Am. Drop Forger, vol. 4, no. 11, Nov. 1918, pp. 437-439, 6 figs. Discusses refractory material, fuel-oil burners and other furnace equipment.

Insulation

Value of Heat Insulation in Furnaces, A. W. Knight. Am. Drop Forger, vol. 4, no. 11, Nov. 1918, pp. 451-453. Discusses particularly use of insulation as applied to annealing ovens.

Pressures

Graphical Examination of Pressures of Hot Gases and Vapors in Furnaces and Chimneys (Étude de quelques cas généraux de pression des gaz chauds et fumées dans les fours et cheminées par représentation graphique), J. Seigle. Bulletin et comptes rendus mensuels de la Société de l'Industrie Minérale, series 5, vol. 14, 3d issue 1918, pp. 133-151, 17 figs. Variation of pressure at different points of enclosure containing hot gases when (1) enclosure is open at top, (2) open at bottom, and when (3) it connects with another enclosure by conduit at top.

HANDLING OF MATERIALS

Dumper

Dumper at Sewalls Point Handles Two Cars at Once. Eng. News-Rec., vol. 81, no. 24, Dec. 12, 1918, pp. 1086-1088, 5 figs. New facilities of Virginian Ry. at coal pier near Norfolk also include cars of 120 tons capacity, and long incline.

Double Car Dumper for Handling Coal, A. F. Case. Iron Age, vol. 102, no. 24, Dec. 12, 1918, pp. 1435-1438, 7 figs. Description of new Sewalls Point plant of Virginian Ry. Co.

HEAT TREATING

Malleable Iron

Tests in Annealing Malleable Iron, H. E. Diller. Iron Trade Rev., vol. 63, no. 25, Dec. 19, 1918, pp. 1414-1416, 4 figs. Experiments conducted to determine time necessary for annealing; study of results and indication of possibility of annealing in 48 hr.; photomicrographs, description of continuous car-type heating furnace. Paper at annual meeting of Am. Foundrymen's Assn.

Steel

Art of Heat Treating, D. N. A. Blacet. Ry. Jl., vol. 25, no. 1, Jan. 1919, pp. 18-20. Economical aspect of adding metallurgist to personnel of plants manufacturing steel parts; general considerations regarding selection of specifications. From Jl. Am. Steel Treaters' Soc.

Surface Combustion

Application of the Surface Combustion Process to Heat Treating and Similar Work, John H. Bartlett, Jr. Proc. Steel Treating Soc., vol. 1, no. 11, pp. 18-32, 12 figs. Generation and application of heat; proportioning of gas and air mixture; description of several installations for heat treating; automatic heat-treating furnaces for large-size shells.

HEATING AND VENTILATION

Circulation Heating

Heating Shop Floors by Circulation. Metal Worker, vol. 90, no. 24, Dec. 13, 1918, pp. 662-663, 6 figs. Scheme to draw cold air from the floor.

Factory Heating

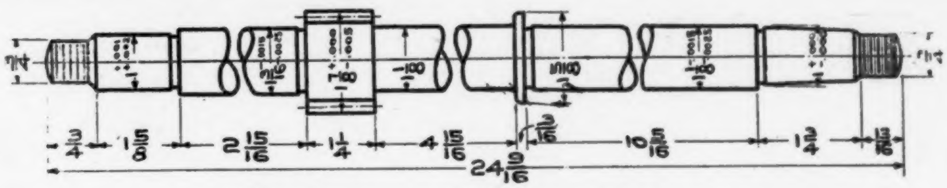
Fuel Wastes in Factory Heating, Charles L. Hubbard. Indus. Management, vol. 57, no. 1, Jan. 1919, pp. 23-25. Sources of losses; suggestions for economies; means for temperature control suited to different systems of heating.

Hospitals

Heating and Power Plant Economies for Hospitals, J. D. Kimball. Modern Hospital, vol. 11, no. 6, Dec. 1918, pp. 437-439. Fundamentals and recommendations of National Economy Program. Paper for convention of Am. Hospital Assn.

Moisture Removal

The Removal of Moisture from Special Rooms and Buildings, Charles L. Hubbard. Domestic Eng., vol. 85, no. 8, Nov. 23, 1918, pp. 283-285 and 313-315, 6 figs. Notes on in-



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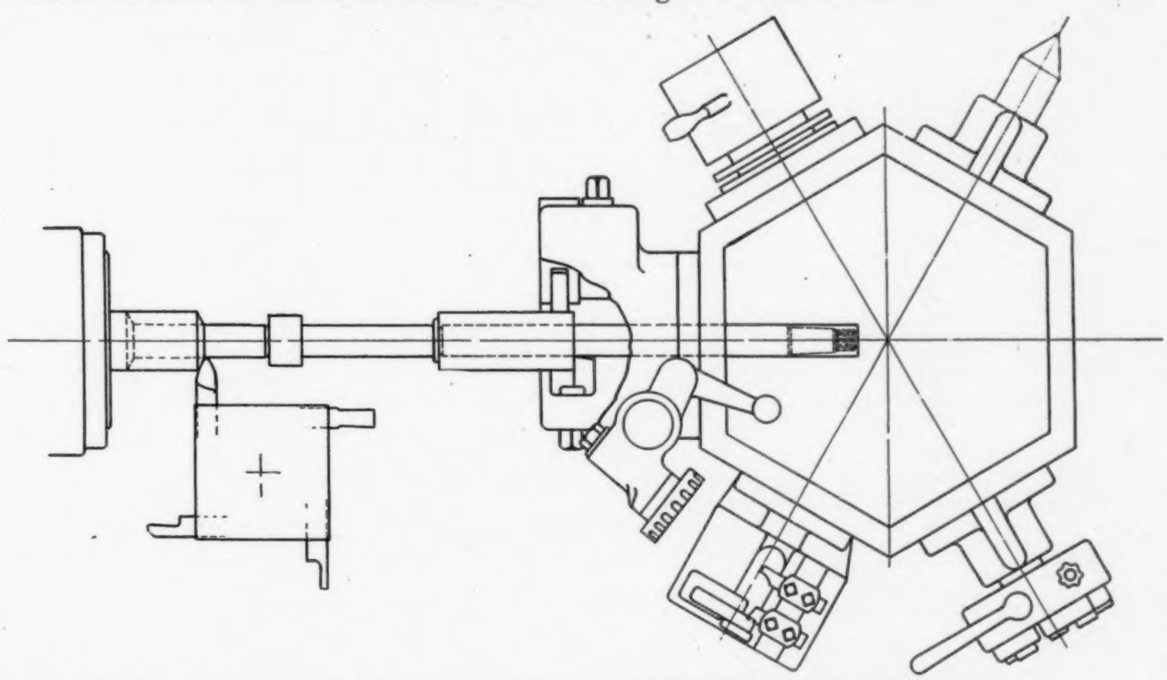

1st Operation:—Turn the 1⅛ in. diameter with the turning tool. At the same time, with a cutter in the square turret, form the 1⅝ in. shoulder and turn the 1⅛ in. diameter behind the shoulder. With another square turret cutter, turn the 1⅞ in. and 1 3-16 in. diameter. The two turrets finishing their work simultaneously.

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3rd Operation:—Center Shaft.
4th Operation:—Turn the 1 in. tapered diameter with taper attachment and nick with square turrent cutter.
5th Operation:—Thread ¾ in. diameter.
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stallation of ventilating systems in laundries, dye houses, paper mills, foundries, flax mills, etc.

Office-Building Ventilation

Air Supply for a Large General Office Building, Samuel R. Lewis. Heat & Vent. Mag., vol. 15, no. 12, Dec. 1918, pp. 21-36, 16 figs. Past and present practice illustrated in remarkable installation for Swift & Co., Chicago.

Radiators

Figuring Direct Radiator Heating Service, W. B. Gray. Metal Worker, vol. 90, no. 24, Dec. 13, 1918, pp. 653-655 and 658, 2 figs. Describes method said to insure correctness and to be of practical application by heating contractors.

Rector System of Gas Heating

New Heating System, Geo. S. Barrows. Gas Indus., vol. 18, no. 12, Dec. 1918, pp. 363-369, 7 figs. Extensive description of Rector system of gas heating.

Steam Heating

Care of Heating and Ventilating Equipment. Harold L. Alt. Power, vol. 48, no. 26, Dec. 24, 1918, pp. 910-912, 3 figs. Describes gravity one-pipe steam system. (Sixth article.)

HOISTING AND CONVEYING

Cableways

Aerial Cableways Successful in Northwest Shipyards. Eng. News-Rec., vol. 82, no. 1, Jan. 2, 1919, pp. 37-40, 5 figs. Similar to loggers cableways; ability to get men expert in handling them is one secret of success; well-planned installations are fast and flexible.

Cranes

Stothert-Pitt 35-Ton Locomotive Crane (Grue-locomotive de 35 tonnes système Stothert et Pitt.) Génie Civil, vol. 73, no. 11, Sept. 14, 1918, pp. 201-203, 5 figs. General arrangement and plans showing dimensions.

HYDRAULIC MACHINERY

Conduits, Loss of Pressure Head

On the High Velocities of Water in Conduits (Sur les grandes vitesses de l'eau dans les conduites), C. Mamichel. Revue Générale de l'Electricité, vol. 4, no. 21, Nov. 23, 1918, pp. 788-790, 1 fig. Experimental results said to have demonstrated loss of pressure head for velocities up to 260 ft. per sec, to be the same as for velocities of 30 ft. per sec.

Penstock Pipe

Saving the Waste in Penstock Pipe Design II), B. F. Jakobsen. Jl. Elec., vol. 41, no. 11, Dec. 1, 1918, pp. 504-505, 2 figs. Presentation and discussion of various formulæ to determine manner in which available money should be distributed among different items in order to get maximum economy. (Continued from Nov. 1 issue.)

Water Hammer

Maxima Excess Pressures Produced by Water Hammer (Sovrapressioni massime nei fenomeni del colpo d'ariete), Maurice Gariel. Abstract of article published in Revue Générale de l'Electricité, Sept. 21. (See Eng. Index, Jan., Mech. Eng., Hydraulic Machy., Water Hammer.)

Notes on the Size and Location in Forced Conduits of Water Hammer Relief Devices. (Remarques au sujet des conditions à remplir par certains dispositifs destinés a atténuer les coups de bélier dans les conduites forcées), Comte de Sparre. Revue Générale de l'Electricité, vol. 4, nos. 19 and 20, Nov. 9 and 16, 1918, pp. 685-690 and 731-740, 1 fig. Nov. 9: Mathematical analysis of phenomena taking place, by reason of elasticity of water and conduit, in surge tank which opens a compensating orifice when water hammer reaches a certain value, the orifice having such dimensions that water hammer will never exceed a permissible maximum. Nov. 16: Application of principles established in preceding installment to calculation of permissible minimum dimensions of surge tanks which will insure a constant value of water hammer during compression.

INTERNAL-COMBUSTION ENGINES

Buckeye Barrett Engine

Buckeye Barrett Crude Oil Engine. Indus. Management, vol. 57, no. 1, Jan. 1919, pp. 72-73, 2 figs. Low-compression type burning heavier grades of fuel and designed for service where an engine must run for weeks under full load without a stop.

Design

The Working Process of Internal Combustion Engines, E. H. Sherbondy. Aerial Age, vol. 8, no. 11, Nov. 25, 1918, pp. 564-568, 7 figs. Historical review of inventions which have tended to improve engine efficiency.

Internal Combustion Engine Development, R. E. Neale. Eng. Rev., vol. 32, no. 5, Nov. 15, 1918, pp. 130-132. Indicates lines open to further development particularly in direction of lightening low-speed engines by adoption of higher piston speeds. (To be continued.)

Diesel-Engine Fuel Pumps

The Design and Construction of Diesel Engine Fuel Pumps, G. L. Kirk. Engineering, vol. 106, no. 2759, Nov. 15, 1918, pp. 549-551, 10 figs. Four systems of oil distribution; system of regulation; determination of clearances; constructional details; control lever.

Ignition

Operation of Internal-Combustion-Engine Magnetos (Sul funzionamento dei magneti di accensione dei motori a scoppio), Emilio Biffi. L'Elettrotecnnica, vol. 5, no. 29, Oct. 15, 1918, pp. 407-411, 6 figs. Various aspects of spark; study of its oscillatory character; conclusions in regard to magneto operation. (Concluded.)

Ignition Timing and Valve Setting, Vermont Wells. Am. Blacksmith, vol. 17, no. 12, Sept. 1918, pp. 291-293, 4 figs. Rules for timing ignition in different makes of cars.

British Magneto Manufacture. Gas & Oil Power, vol. 14, no. 158, Nov. 7, 1918, pp. 20-22, 3 figs. General dimensions and brief outline of magneto manufactured by British Lighting and Ignition Co.

Dixie Standard Aircraft Magnetos. Automotive Indus., vol. 39, no. 23, Dec. 5, 1918, pp. 954-957, 6 figs. Type which may be adapted to various engines; methods used in manufacture of magneto magnets.

Semi-Diesel Engines

Semi-Diesel Oil Engines, F. D. Weber. Jl. Elec., vol. 41, no. 12, Dec. 15, 1918, pp. 549-550, 4 figs. Types being used to equip auxiliary wooden schooners of 500 to 3000 tons capacity and straight motor schooners up to 1000 tons capacity.

The Semi-Diesel Oil Engine, James Richardson. Gas & Oil Power, vol. 14, no. 158, Nov. 7, 1918, pp. 23-25, 9 figs. Development and operation. From paper before Diesel Engine Users' Assn. Also Macy. Market, no. 944, Dec. 6, 1918, pp. 17-18, 9 figs. Definition; compression pressure; flexibility; range of working.

Valves, Poppet, Air Flow Through

Air Flow Through Poppet Valves. Automotive Indus., vol. 39, no. 25, Dec. 19, 1918, pp. 1047-1051, 5 figs. Experimental investigation from which writer concludes that coefficient of efflux is practically constant for all pressure drops and nearly the same for valves of different sizes, at equal lifts expressed in per cent. of their respective diameters; considerations on number of inlet valves to use.

Air Flow Through Poppet Valves. Automotive Eng., vol. 3, no. 10, Dec. 1918, pp. 461-463, 1 fig. Data on valve sizes; investigation of merits of multiple valves. (To be continued.)

Winton Marine Engine

The Latest Winton Marine Oil Engine. Automotive Eng., vol. 3, no. 10, Dec. 1918, pp. 447-450, 5 figs. Review of mechanical details of 500 and 250-hp. units of Diesel-type reversible motor.

See also ELECTRICAL ENGINEERING, Electrophysics (Spark-Plug Insulators).

LUBRICATION

Bearing Design

Oiling System and Bearing Designs, A. E. Windram. Tran. Inst. Marine Engrs., vol. 30, no. 238, Oct. 1918, pp. 209-216, 13 figs. Method of making main bearing, crankpin and crosshead brasses oiltight by means of drilling crank webs into oil rings or grooves turned round center of journal, and corresponding oil ring or groove in center of brasses connected with pipes from brasses to brasses, which are made oiltight by sealing rings on ends of brasses.

Oils

Properties of Oils and Their Relation to Lubrication (Propiedades de los aceites; su relacion con la lubricación). Boletin de la Sociedad de Fomento Fabril, year 35, no. 8, Aug. 1918, pp. 537-542. Significance of tests for acidity, carbon-residue, oxidation, volatility, surface tension, emulsion, heat and density.

See also MARINE ENGINEERING, Ships (Lubrication).

MACHINE ELEMENTS AND DESIGN

Crankshafts

Hair-Line Defects in Crankshafts, P. J. Piccirilli. Automotive Industries, vol. 39, nos. 25 and 26, Dec. 19 and 26, 1918, pp. 1041-1044, 1104-1105 and 1122, 15 figs. Metallographic study and physical tests of chrome-nickel steel crankshafts to determine nature and effect of so-called hair-line defects on their physical strength.

Springs

A new theory of Plate Springs, David Landau and Percy H. Parr. Jl. Franklin Inst., vol. 186, no. 6, Dec. 1918, pp. 699-721, 8 figs. Mathematical generalization of propositions advanced in first paper, vol. 185, Apr. 1918, p. 481. Special attention given to effect of tapering ends and constructing springs so that leaves continue in contact everywhere on application of load. (To be concluded.)

The Springs of the Car (IV), F. M. Paul. Am. Blacksmith, vol. 17, no. 12, Sept. 1918, pp. 298-299, 8 figs. Considers effect of thickness in regard to deflection and load.

MACHINE SHOP

Chisel

The Cold Chisel, J. A. Lucas. Power, vol. 48, no. 24, Dec. 10, 1918, pp. 838-841, 27 figs. Description of various types of cold chisels and their uses.

Cylinder Manufacture

Cylinder Boring and Reaming, Franklin D. Jones. Machy., vol. 25, no. 5, January 1919, pp. 383-394, 20 figs. First of series of articles dealing with boring, reaming and grinding of cylinders, and tools, fixtures and machines used.

Manufacture of Cylinders for the Hall-Scott Aeroplane Engine, Richard Vosbrink. Metal Trades, vol. 9, no. 12, Dec. 1918, pp. 475-479, 11 figs. Operations followed at California plant to produce accurate results.

Design

Novel Plant of American Tool Company, C. L. Smith. Iron Age, vol. 103, no. 1, Jan. 2, 1918, pp. 29-33, 10 figs. Latest ideas in heating and ventilating, lighting features, transportation facilities, sanitation, handling turnings; unusual drive for planers; machine foundations.

Designing a Shop for Present Day Needs, C. E. Edmund. Am. Drop Forger, vol. 4, no. 11, Nov. 1918, pp. 431-433. Considerations on location, construction and operation of forge plant.

Gages

Notes on the Computing of Gauge Tolerances, M. H. Potter. Can. Machy., vol. 20, no. 24, Dec. 12, 1918, pp. 670-672, 6 figs. Classifies and studies the more frequent troubles experienced with gages and gives rules and formulæ for computing allowable tolerances for various gages. A square hole gage and a depth gage are referred to but the rules proposed apply in general to all gages.

Apparatus for Checking Screw Threads. Automotive Indus., vol. 38, no. 24, Dec. 12, 1918, pp. 1008-1010, 4 figs. Methods of operating machines used for inspection of plug and ring thread gages and similar threaded parts requiring great accuracy.

Flush-pin, Sliding Bar and Hole Gages, Erik Oberg. Machy., vol. 25, no. 5, Jan. 1919, pp. 404-412, 34 figs. Principles involved and procedure followed by Pratt & Whitney Co. in developing gaging systems for interchangeable manufacture. Fourth article.

Contour or Profile Gages, Erik Oberg. Machy., vol. 25, no. 4, Dec. 1918, pp. 301-308, 31 figs. Principles involved and procedure followed in developing gaging systems for interchangeable manufacture. Based upon experience of Pratt & Whitney Co. in furnishing gaging equipment for small arms and heavy ordnance work. Third article.

Gear Cutting

The Manufacture of Spiral Bevels. Automobile Engr., vol. 8, no. 121, Dec. 1918, pp. 336-339, 6 figs. Description of Gleason machine for that purpose.

Problem of the Theoretically Correct Involute Hob, Nikola Trbojevich. Machy., vol. 25, no. 5, Jan. 1919, pp. 429-433, 3 figs. Mathematical theory developed.

Grinding

Grinding of Hardened Work, C. H. Norton. Proc. Steel Treating Research Soc., vol. 1, no. 11, pp. 15-17. Norton Grinding Co.'s experience; suggestions in regard to grinding.

Grinding Operations on "Caterpillar" Tractor Parts, Frank A. Stanley. Am. Mach., vol. 50, no. 1, Jan. 2, 1919, pp. 1-4, 7 figs. Grinding operations include finishing of great variety of gears, bushings, shafts, piston pins, case covers, etc.; details of wheels, limits of accuracy, etc.

Grinding Round Work Without Centers. Am. Mach., vol. 50, no. 1, Jan. 2, 1919, pp. 4-5, 4 figs. Describes new grinding machine built by Detroit Tool Co.

Pistons and Rings

The Manufacture of Pistons and Rings, A. Thomas. Automobile Engr., vol. 8, no. 121, Dec. 1918, p. 358, 3 figs. Notes on operation of Potter-Johnston automatic machine.

Repair Work

Automotive Repair Work in the Machine Shop, Donald A. Hampson. Can. Machy., vol. 20, no. 24, Dec. 12, 1918, pp. 665-668, 7 figs. Practical observations on methods of increasing pedal leverage, making a working clutch, inserting cotters in unseen holes, fitting rings in cylinder, increasing size of cast-iron parts, reaming undersize in cast iron and other similar operations.

The Repair Shop, Automobile Engr., vol. 8, nos. 120 and 121, Nov. 1918 and Dec. 1918, pp. 312-315 and 341-345, 25 figs. Nov. 1918: Notes on heavy vehicle design from viewpoint of repair and maintenance. Radiator; engine; clutch; engine suspension; gear box; universal joints and brakes. Dec. 1918: Deals with rear axle; road wheels and bearings; chassis lubrication, spring and pins; frame; steering and front axle; controls.

MACHINERY, METAL-WORKING

Boring Mill

Blomquist-Eck Horizontal Boring Mill. Machy., vol. 25, no. 5, Jan. 1919, pp. 465-466, 2 figs. General description with illustrations.

Lathes

Large Lathes for Machining Turbine Spindles. A. M. M. Machy., vol. 25, no. 5, Jan. 1919, pp. 439-442, 4 figs. Illustrated description of some large lathes.

Planer

Newton Upright Generating Planer. Machy., vol. 25, no. 5, Jan. 1919, pp. 473-474, 4 figs. Description of machine built by Newton Machine Tool Works, Inc., Philadelphia, Pa.

Reamers

Types of Reamers and Their Use, E. C. Peck. Machy., vol. 25, no. 4, Dec. 1918, pp. 335-337, 6 figs. Description of various types of reamers.

Relieving Machine

Universal Relieving Machine for Hobs and Cutters. Machy., vol. 25, no. 5, Jan. 1919, pp. 467-468, 2 figs. Description of machine built by T. C. M. Mfg. Co., Harrison, N. J.

Steel, High-Speed

The Evolution of a High-Speed Steel Tool, T. L. Thorne. Proc. Steel Treating Research Soc., vol. 1, no. 11, pp. 33-43. Analyses of several high-speed steel specimens; influence of silicon, manganese, sulphur, phosphorus, chromium, vanadium and tungsten on characteristic properties of steel; practice followed in its manufacture; forms of furnaces used; heat-treating and tools.

A New Air-Hardening High-Speed Steel. Am. Drop Forger, vol. 4, no. 11, Nov. 1918, pp. 435-436, 2 figs. Experiences of users of a steel made without tungsten by Cuyahoga Crucible Foundry Co.

Stellite

Stellite and High-Speed Steel Compared. Iron Age, vol. 102, no. 26, Dec. 26, 1918, pp. 1584-1585, 2 figs. Hardness at different temperatures; stellite softer in raw state; relative cutting tests on three materials.

See also RAILROAD ENGINEERING, Shops (Tools, Brass-Working); MUNITIONS AND MILITARY ENGINEERING, Tools for Shell Manufacture.

MATERIALS OF CONSTRUCTION AND TESTING OF MATERIALS

Notched Bars

Some Experiments on Notched Bars, H. T. Philpot. Jl. Soc. Automotive Engrs., vol. 3, no. 6, Dec. 1918, pp. 347-357, 3 figs. Tests to obtain dimensions and shapes for round notched bar for use in acceptance tests on heat-treated steels in place of standard square type A test piece. Paper before Instn. Automobile Engrs. of Great Britain.

Hardness

The Ludwik Hardness Test, W. Cawthorne Unwin. Jl. Instn. Mech. Engrs., no. 6, Nov. 1918, pp. 485-492. Traces relationship between indentation hardness tests of ductile metals.

The Value of the Indentation Method in the Determination of Hardness, R. G. C. Batson. Jl. Instn. Mech. Engrs., no. 6, Nov. 1918, pp. 463-483, 6 figs. Deals with determination of hardness by means of indentation produced by a static load and by impact of a ball or cone.

Malleable Iron

Malleable Iron in Engineering Construction, H. A. Schwartz. Foundry, vol. 47, no. 317, Jan. 1919, pp. 19-24, 16 figs. Engineering properties and characteristics of malleable iron which recommend it for wide range of uses. From paper before Am. Foundrymen's Assn.

Optical Stress Determination

Stress Optical Experiments, A. R. Low. Flight, vol. 10, nos. 48-49, Nov. 28 and Dec. 5, 1918, pp. 1355-1356 and 1379-1381, 12 figs. Determination of stress by optical methods. Nov. 28: Elementary theory; changes in uniform field as stress increases; null method of measurement; appearances in non-uniform field; neutral, isochromatic and isoclinic lines. Dec. 5: Simplifications in case of bar under flexure; error of obliquity; observation of errors of parallax; general accuracy of optical observations of stress. Paper before Royal Aeronautical Soc. (To be continued.)

Rubber

Ageing of Vulcanized Plantation Rubber, Henry P. Stevens. Jl. Soc. Chem. Indus., vol. 37, no. 21, Nov. 15, 1918, pp. 305T-306T, 4 figs. Tests on ordinary pale rolled sheet and unrolled sheet.

Testing Machines

Testing Machines in Industrial Laboratories, H. S. Primrose and J. S. Glen Primrose. Can. Machy., vol. 20, nos. 23 and 25, Dec. 5 and 19, 1918, pp. 644-647 and 696-699, 17 figs. Necessity of establishing specifications properly controlled by analysis and test in purchasing engineering materials and features of various testing machines. From Engineering.

Testing of Materials

The Experimental Study of the Mechanical Properties of Materials, W. Cawthorne Unwin. Jl. Instn. Mech. Engrs., no. 6, Nov. 1918, pp. 405-439, 13 figs. Early researches; chain-cable testing machines; calibration of testing machines; large testing machines; Emery testing machine at Bureau of Standards; tests of reception-tension tests, Wöhler test, hardness tests, notched-bar tests.

Wood

Some Tests of Douglas Fir after Long Use, Arthur C. Alvarez. Univ. of Cal. Publications in Eng., vol. 2, no. 2, Nov. 18, 1918, pp. 57-118, 17 figs. Results of 1200 tests on strength, elastic properties and moisture content; includes 27 tables of measured and computed mechanical coefficients.

MEASUREMENTS AND MEASURING APPARATUS

Calibration

On the Choice of a Uniform Temperature for the Calibration of Measuring Instruments (Sur le choix d'un degré uniforme de température pour l'étalonnage des instruments de mesure), Ch. Cochet. Revue Générale de l'Electricité, vol. 4, no. 20, Nov. 16, 1918, pp. 740-742. Report of Commission de Normalisation des Ingénieurs des Arts et Métiers de Boulogne-sur-Seine, recommending adoption of 0 deg. cent. as standard.

Calorimeters

Calorimetric Methods and Devices, Walter P. White. Jl. Am. Chem. Soc., vol. 40, no. 12, Dec. 1918, pp. 1887-1889, 3 figs. Application of rules for calorimetric precision derived by writer to jacket covers and stirrers; vacuum-jacketed vessels; adiabatic method; aneroid or dry calorimeters; double or differential calorimeters; measured-shield calorimeters.

Coke Testing

Coke Factors Affecting Furnace Operation, G. D. Cochrane. Blast Furnace, vol. 6, no. 12, Dec. 1918, pp. 502-504 and 512, 1 fig. Coke-testing machine employed in experiment for determining coke hardness. Mechanical condition of coke an important factor in furnace operation.

Picnometer

A Picnometer Operated as a Volumeter, H. G. Schurecht. Jl. Am. Ceramic Soc., vol. I, no. 8, Aug. 1918, pp. 556-558, 1 fig. Same as ordinary picnometer but of sufficiently large size and opening to permit introduction of a briquet into the bottle. Volume of briquet determined from standard formula in terms of weight and specific gravity of liquid.

Salinometers

An Instrument for Recording Sea-Water Salinity, A. L. Thuras. Jl. Wash. Acad. Sci., vol. 8, no. 21, Dec. 19, 1918, pp. 676-687, 3 figs. Surface salinity of ocean determined by measuring ratio of resistances of sea water in two similar electrolytic cells. Accuracy limited by that with which salinity of standard sea water carried in sealed cell is known. Table given showing conductivity of sea water throughout range of concentration found in open ocean.

Scales

Oscillations in Scales, Eugene Motchman. Scale Jl., vol. 5, no. 3, Dec. 10, 1918, pp. 7-9, 4 figs. Use of modern 150-ton beam applied to railroad track scales without loose weight. (Continuation of serial.)

MECHANICAL PROCESSES

Boilers

Boiler Making in an English Shop, A. L. Haas. Boiler Maker, vol. 18, no. 12, Dec. 1918, pp. 333-337, 11 figs. Hopwood, Cornish, Lancashire and Britannia types; shop conditions; position drilling; combustion chamber crown; seven-hour test.

Manufacturing Marine Steam Boilers, E. A. Suverkrop. Am. Mach., vol. 49, no. 26, Dec. 26, 1918, pp. 1155-1163, 21 figs. Description of building operations of single-ended, three-furnace Scotch marine boilers at shop of Sun Shipbuilding Co., Chester, Pa., where production has reached as high as nine per month.

Cans

A Modern Can-Making Plant in a Baking Powder Factory, J. V. Hunter. Am. Mach., vol. 49, no. 26, Dec. 26, 1918, pp. 1173-1176, 11 figs. Description of process of making tin cans.

Chains

The Manufacture of Diamond Transmission Chain, J. V. Hunter. Am. Mach., vol. 49, no. 23, Dec. 12, 1918, pp. 1077-1080, 14 figs. Assembling work. Fourth article.

Clocks

Applications of Magnetic Gears in Electric Clockmaking (Engrenages magnétiques. Application à l'horlogerie électrique), Pierre Seve. Comptes rendus des séances de l'Académie des Sciences, vol. 167, no. 19, Nov. 4, 1918, pp. 681-683. Mutual action of two disks having magnets attached at regular intervals in their peripheries; disposition to provide magnetic escapement.

Engines, Oil

Quantity Production of Engines at the Skandia Pacific Plant, Geo. N. Somerville. Metal Trades, vol. 9, no. 11, Nov. 1918, pp. 429-434, 10 figs. Operations in various sizes of oil engines.

Lubricator

Manufacturing a Mechanical Lubricator, M. E. Hoag. Am. Mach., vol. 49, no. 26, Dec. 26, 1918, and vol. 50, no. 1, Jan. 2, 1919, pp. 1183-1185 and 23-26, 18 figs.

Plates

See Rolling Mills below.

Quarrying

Rock Quarrying for Cement Manufacture, Oliver Bowles. Department of Interior, Bur. of Mines, bul. 160, min. technology 22, 160 pp., 31 figs. Chief types of cement; growth of cement industry in U. S.; character of raw materials used; quarrying method and equipment with special reference to drilling and blasting; rock mining and prospecting.

Radiators

Building Radiators for Automobiles and Other Purposes, Ellsworth Sheldon. Am. Mach., vol. 49, no. 26, Dec. 26, 1918, pp. 1165-1169, 18 figs. Description of certain processes involved in manufacture of cellular type of radiator.

Rolling Mills

Design of Rolls for Making Ship and Boiler Plates, S. W. Staniford. Machy., vol. 25, no. 5, Jan. 1919, pp. 396-400, 1 fig. Rolling-mill practice; drafts of slabbing and plate-mill rolls; universal mill; surface speed of rolls, rolling tin plate.

The Liberty Mill of the Carnegie Steel Company, Charles A. Menk and F. L. Hunt. Elec. Jl., vol. 15, no. 12, Dec. 1, 1918, pp. 483-489, 18 figs. Layout of buildings and equipment of completely electrically-driven plate mill.

Valley Company Now Rolls Plates. Iron Trade Rev., vol. 63, no. 25, Dec. 19, 1918, pp. 1403-1406, 3 figs. Operation and details of electrically-driven steel plant with annual capacity of 350,000 tons.

Selecting Proper Size Mill Rolls, F. Johnson. Iron Trade Rev., vol. 63, no. 26, Dec. 26, 1918, pp. 1466-1468, 7 figs. Outline of relative advantages obtained by using rolls of small or large diameter for effecting a given reduction; effect of cold-working on physical properties of various metals. From paper before Birmingham Metallurgical Soc., England.

A New Departure in Rolling Mills. Iron Age, vol. 103, no. 1, Jan. 2, 1919, pp. 41-44, 6 figs. Neither lifting tables nor reversing drive employed; design developed by Mackintosh, Hemphill & Co.

Lukens Plate Mill is Largest in the World. Iron Age, vol. 103, no. 1, Jan. 2, 1919, pp. 56-59, 5 figs. Description of the mill.

Brier Hill Steel Co.'s New Plate Mill. Iron Age, vol. 102, no. 25, Dec. 19, 1918, pp. 1521-1524, 6 figs. World's largest mill building; houses and 84- and 132-in. units; power entirely electric; boiler plant dispensed with.

Blooming Mill Now Rolling Plates. Iron Trade Rev., vol. 63, no. 23, Dec. 5, 1918, pp.

Stoker Service

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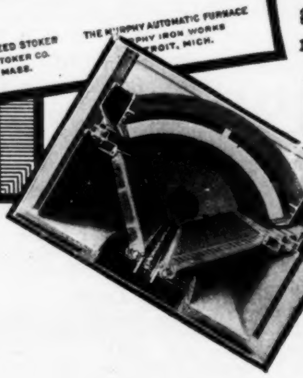

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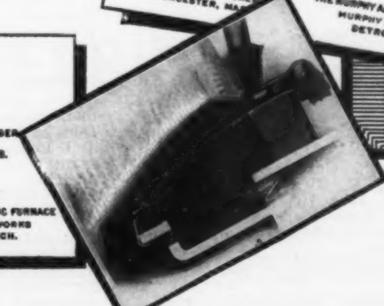

1285-1288, 4 figs. Account of rebuilding of mill, originally designed for breaking down ingots, to aid rapid transformation from shell steel to peace-time commercial product.

Sawmills

Small Sawmills: Their Equipment, Construction, and Operation, Daniel F. Seerey. U. S. Department of Agriculture, bul. 718, Dec. 17, 1918, 68 pp. Suggestions to portable sawmill operators regarding methods of organization, milling, and lodging which have been proved by experience to give the best results. Written particularly for operators in National Forest timber.

Shell and Ivory Articles

Making Shell Buckles and Brooches, Robert Mawson. Am. Mach., vol. 50, no. 1, Jan. 2, 1919, pp. 20-22. 13 figs. Making of buckles and brooches from shells and ivory performed as far as possible on machines, but some operations are done by hand.

Shovels

Shovels Made Out of Old Locomotive Tires, W. S. Standiford. Can. Machy., vol. 20, no. 25, Dec. 1918, pp. 693-695, 3 figs. Description of manufacturing process.

Tanks, Pressure

Tables for the Design of Pressure Tanks, John A. Cole. Boiler Maker, vol. 18, no. 12, Dec. 1918, pp. 349-351. Specifications for cylindrical pressure tanks; single-riveted lap girth seams, for use when girth and longitudinal seams are the same size; safe working pressures for cylindrical tanks of various diameters; safe working pressures on convex and dished heads.

Tractor

Manufacturing of Farm Tractor, M. E. Hoag. Am. Mach., vol. 49, no. 25, Dec. 19, 1918, pp. 1135-1137. Description of shop arrangement of Moline Plow Co.

MECHANICS

Balancing

Dynamic and Static Balancing, Edward K. Hammond. Machy., vol. 25, nos. 4 and 5, Dec. 1918 and Jan. 1919, pp. 285-292 and 422-426, 26 figs. Two articles explaining conditions which must be fulfilled in balancing machine members, and methods of conducting work.

Stress Theory

The Specification of Stress, Part V, R. F. Gwyther. Memoirs & Proc. Manchester Literary & Phil. Soc., vol. 62, part 1, Aug. 7, 1918, pp. 1-11. Formal solution of elastic stress equations; theory of displacements of materials bodies as consequence of stress; results of hypothesis that nine elements of stress may be functions of nine first differential coefficients of components of some vector; fundamental equations estimating forces causing rate of change of momentum and expression of corresponding rate of change of momentum.

Vibration

Vibration: Mechanical, Musical and Electrical, Edwin H. Barton. Sci. Am. Supp., vol. 87, no. 2244, Jan. 4, 1919, p. 5. Analogies and experimental verification of laws governing vibratory motion. Discourse delivered at Royal Instn. From Engineering.

MOTOR-CAR ENGINEERING

Acceleration Determined by Mechanical Differentiometer

Automobile Performance Analyzed by Mechanical Differentiation. Armin Elmendorf. Automotive Indus., vol. 40, no. 1, Jan. 2, 1919, pp. 11-16, 17 figs. Determination of acceleration from time and distance observations by means of mechanical differentiometer.

Carburetors

Carburetor Adjustments of Twenty Leading Automobiles, George H. Murphy. Am. Blacksmith, vol. 17, no. 12, Sept. 1918, pp. 301-303, 9 figs. Instructions for making adjustments. (To be concluded.)

Design

Post-War Chassis. Automobile Engr., vol. 8, nos. 120 and 121, Nov. and Dec. 1918, pp. 304-305 and 339-340. Nov. 1918: Possible effects of aircraft engine experience and other factors bearing upon design. Pistons; valve position and actuation; valves. Dec. 1918. Valve springs; valve rockers; connecting rods; crankshafts; lubrication.

Analysis of Gas and Gasoline High-Speed Engine Design, Harry R. Ricardo. Int. Mar. Eng., vol. 23, no. 12, Dec. 1918, pp. 673-677. Groups of mechanical losses depend upon form of pipe work; volumetric efficiency and piston design. Second article.

Differentials

The Allen Self-Locking Differential. Automotive Indus., vol. 39, no. 26, Dec. 26, 1918, p. 1099, 2 figs. Device embodying reversible ratchet principle. Drive on curves is through inner wheel.

Engines

Used Airplane Engines for Automobile Installation, Frank F. Tenney. Automotive Eng., vol. 3, no. 10, Dec. 1918, pp. 457 and 463. Why engines which have outlived their usefulness in air service may still be of service for other uses.

Exports

Export Opportunities for Automotive Products, 11. Automotive Eng., vol. 3, no. 10, Dec. 1918, pp. 454-456. Export of American combustion engine from 1914 to 1917; motor boats and marine machinery in Siam; demand for motor boats in Denmark; high fuel limits in South America; market tractors in Cuba, tractors in farming sections of Wales. (Continuation of serial.)

Cultivating Japanese Automotive Field (III), Tom O. Jones. Automotive Indus., vol. 39, no. 23, Dec. 5, 1918, pp. 970-971. Types of automobiles desired; equipment and finish; automobile building in Japan. (To be continued.)

France

The Automobile after the War, Georges Cote. Automotive Indus., vol. 39, no. 25, Dec. 19, 1918, pp. 1057-1058 and 1075. Views and suggestions to automobile manufacturers of France as to means and methods of meeting reconstruction problems and foreign competition.

Fuels

Benzol Superior to Gasoline as Auto Fuel. Gas Age, vol. 42, no. 12, Dec. 16, 1918, pp. 548-550, 2 figs. Result of comparative tests made by Automobile Club of America; 90 per cent benzol said to give higher brake hp. at less fuel consumption by the motor.

Liberty Fuel

Liberty Fuel, A Chemical Marvel, E. W. Roberts. Gas Eng., vol. 21, no. 1, Jan. 1919, pp. 1-4, 8 figs. Description of fuel with report of U. S. Government tests.

Properties of Liberty Fuel and Results of Economy Tests. Power, vol. 49, no. 1, Jan. 7, 1919, pp. 9, 2 figs. Particulars as to nature and characteristics of new fuel.

Headlights

Headlamp Glare. Jl. Soc. Automotive Engrs., vol. 3, no. 6, Dec. 1918, pp. 364-366. Account of work done and bases followed by committee of Illum. Eng. Soc. in preparation of headlight specifications.

Manufacturing Problems

Why So Many Motor Models? George F. Crouch. Motor Boat, vol. 15, no. 23, Dec. 10, 1918, pp. 18-20, 3 figs. Observes that concentration by manufacturer on fewer sizes would mean better motors, better service and lower cost.

Radiators

Principles of Tractor Radiator Design, E. Goldberger. Automotive Indus., vol. 38, no. 24, Dec. 12, 1918, pp. 1000-1003, 3 figs. Equations showing dependence of radiator capacity on temperatures, rates of flow and inherent characteristics; advantages of thermosiphon circulation in tractor work.

Steam Vehicles

A New British Coke-Fired Steam Commercial Vehicle. Automotive Indus., vol. 39, no. 22, Nov. 28, 1918, pp. 919-922, 6 figs. Three-ton chassis having automatic control of steam-generating functions and manual control of devices arranged as on a gasoline vehicle.

Suspension

Houdaille Brings Out Adjustable Car Suspension, F. W. Bradley. Automotive Indus., vol. 38, no. 24, Dec. 12, 1918, pp. 1004-1005, 2 figs. Device which permits moving points of attachment of springs to car frame.

Tractors

S. W. H. Tractor a New Cleveland Product. Automotive Indus., vol. 39, no. 26, Dec. 26, 1918, pp. 1085-1088, 5 figs. Three-plow machine with pressed-steel semi-frame bolted to front end of transmission housing; engine and transmission independent.

The Auto-Tiller, a Two-Horse Team Replacement Unit. Automotive Eng., vol. 3, no. 10, Dec. 1918, pp. 473-477, 5 figs. Field of utility and mechanical details of motor tractor for farm work operated by one man from a fixed position.

Trucks

Regulation of Speed, Weight, Width and Height of Motor Trucks Discussed, George M. Graham. Eng. News-Rec., vol. 81, no. 25, Dec. 19, 1918, pp. 1109-1112. Regulation, while necessary, should not restrict expansion of motor truck; table of proposed dimensions, speeds, weights, and fees presented.

Double Reduction Gear Drive for Heavy Duty Trucks. Am. Blacksmith, vol. 18, no. 2, Nov. 1918, pp. 32-33. Operation of drive in new 3- and 5-ton White models.

Wheel

An Elastic Wheel (La roue élastique I. D.). Génie Civil, vol. 73, no. 20, Nov. 16, 1918, pp. 393-394, 2 figs. Design which by means of helical springs attached to rim permits tangential effort on wheel to be distributed over a number of contact points of spring.

See also MECHANICAL ENGINEERING, Mechanical Processes (Radiators); Internal-Combustion Engines (Buckeye Barrett Engine); Machine Shop (Repair Work).

PIPE

See MECHANICAL ENGINEERING, Corrosion (Pipe).

POWER GENERATION

Exhaust Steam

Utilization of Exhaust Steam in Collieries for the Generation of Electrical Energy (Considérations sur l'utilization des vapeurs d'échappement dans les houillères en vue de la production d'énergie électrique), A. Barjou. Industrie Electrique, year 27, nos. 621, 623, 627, 631 and 634, May 10, June 10, Aug. 10, Oct. 10 and Nov. 25, 1918, pp. 166-171, 212-217, 287,293, 373-379 and 425-430, 26 figs. May 10: theoretical aspect of problem. June 10: systems of regulating exhaust steam. Aug. 10: utilization of exhaust steam in low-pressure turbines. Oct. 10: Westinghouse-Leblanc system of condensation. Nov. 25: Brequet-Delaporte condenser.

Tides

Tides as a Source of Mechanical Power (Etude sur l'utilization des marées pour la production de la force motrice), F. Maynard. Revue Générale de l'Electricité, vol. 4, nos. 19, 20 and 21, Nov. 9, 16 and 23, 1918, pp. 697-715, 749-762 and 793-802, 14 figs. Brief description of 87 patents granted in France concerning devices for utilization of tidal energy and analyses of their practical values. (To be continued.)

POWER PLANTS

Boiler Water

Control of Concentrated Boiler Water is Essential, Hartley LeH. Smith. Elec. Ry. Jl., vol. 52, no. 25, Dec. 21, 1918, pp. 1087-1091, 1 fig. Methods used for control of concentration in boilers; how ratio of concentration from feedwater to boiler water is determined; calculation of boiler concentration control charts.

Coal Economy

Coal Economy in a Small Steam Generating Station. Elec. Rec., vol. 24, no. 6, Dec. 1918, pp. 27-28, 3 figs. Results secured in 290-kw. plant given as example of coal saving.

Flue-Gas Analysis

Controlling Efficiency of Combustion, E. A. Uehling. Power, vol. 48, no. 26, Dec. 24, 1918, pp. 921-923. Use of flue-gas analysis for controlling combustion.

Furnace Indicating Instruments

Meters and Gages in Boiler Operation, E. A. Uehling. Power, vol. 48, no. 24, Dec. 10, 1918, pp. 842-844. Use of meters and gages in diagnosing condition of furnace.

Hand Firing

Power Plant Management; Hand Firing, Robert June. Power House, vol. 11, no. 11, Nov. 1918, pp. 315-317, 3 figs. Standard practice; proper combustion conditions; thickness of fire; minimization of smoke.

Individual Plants

Steam-Generating Equipment of Mark Plant, Gordon Fox and F. E. Grenley. Power Plant Eng., vol. 22, no. 24, Dec. 15, 1918, pp. 981-984, 3 figs. Description of certain features of new plant of Steel & Tube Co. of America.

Power Plants in 1918

Review of the Year in the Power Field. Power, vol. 49, no. 1, Jan. 7, 1919, pp. 2-8. What has been new and of especial interest during 1918.

Scale in Boilers

Scale in Water-Tube Boilers. Monthly Jl. Utah Soc. Engrs., vol. 4, no. 9, Sept 1918, pp. 175-176. Results of cleaning a 400-hp. Babcock & Wilcox boiler after operating it for six months, with table indicating the amount of scale taken from each of its 14 sections.

Transmission Losses

Wasting Power in the Using, L. W. Alwyn-Schmidt. Power Plant Eng., vol. 22, no. 24, Dec. 15, 1918, pp. 984-987. Transmission losses, waste of power at machine and methods suggested for overcoming them.

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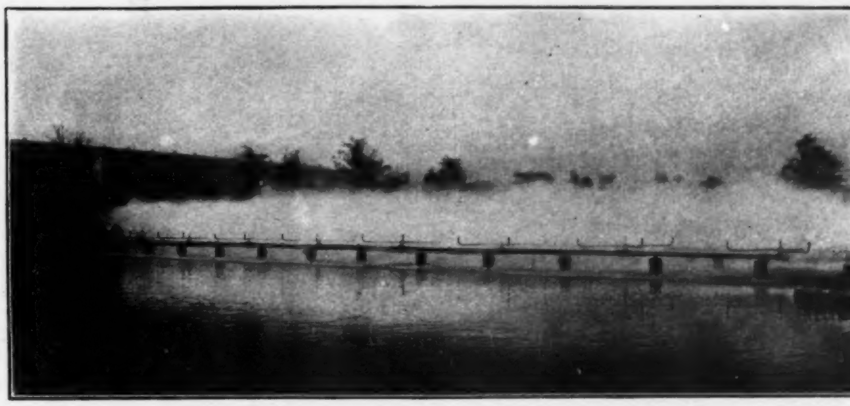

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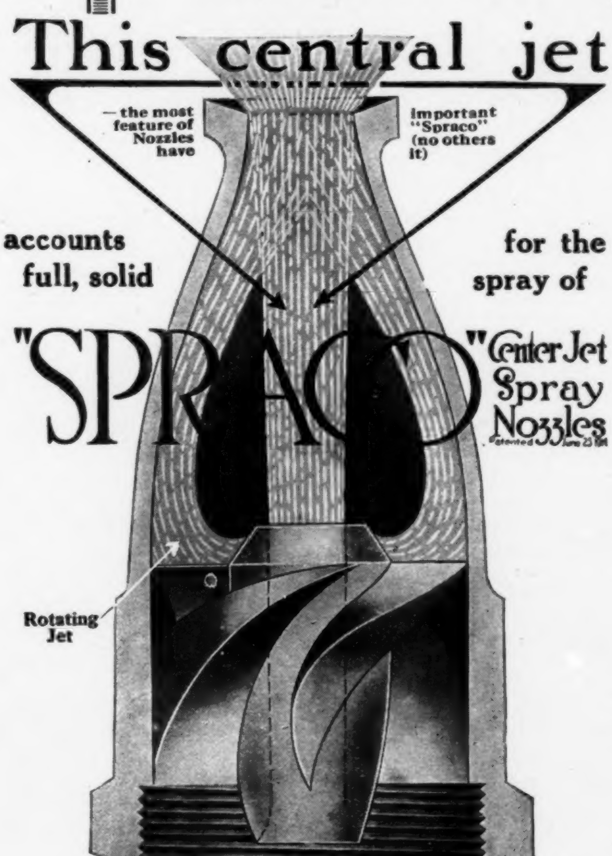

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Turbo-Generator Plants

Operating Methods That Increase Economy, C. F. Hirshfeld and C. L. Karr. Elec. World, vol. 72, no. 24, Dec. 14, 1918, pp. 1120-1124, 2 figs. Apply to turbo-generator plants; distribution of loads on boilers and turbines and economical operation of auxiliaries discussed.

Economic Operation of Steam Turbo-Electric Stations, T. C. Hirshfeld and C. L. Karr. Elec. Rev., vol. 73, nos. 23 and 24, Dec. 7 and 14, 1918, pp. 886-890 and 923-928, 5 figs. Bureau of Mines Technical Paper discussing fuel-economy factors, load, distribution between units, boiler room and auxiliaries operation.

Waste Heat

Waste Heat for Steam Generation, Thomas B. Mackenzie. Engineering, vol. 106, no. 2759, Nov. 15, 1918, pp. 567-569, 2 figs. Utilization of waste heat from open-hearth furnaces for generation of steam. Paper before Iron & Steel Inst., Sept. 1918.

PRODUCER GAS

Kiln, Gas-Fired

Heat Balance on a Producer-Gas Fired Chamber Kiln, R. K. Hursh. Jl. Am. Ceramic Soc., vol. 1, no. 8, Aug. 1918, pp. 567-577, 1 fig. Data based on tests of a kiln of 16 chambers, each holding 50,000 standard-sized brick, and on three 6-ft. water-sealed gas producers of the pressure type.

Open-Hearth Furnaces

Waste Heat from Open Hearth Furnaces, Thomas B. Mackenzie. Blast Furnace, vol. 6, no. 12, Dec. 1918, pp. 488-492, 3 figs. Analysis of producer gas supplied to furnace; theoretical principles governing operation of waste-heat boilers; suggestions concerning layout of plant and boiler setting. Paper before British Iron & Steel Inst. (Concluded.)

Wood

The Production of Power-Gas from Wood, Leslie B. Williams. Min. Mag., vol. 19, no. 5, Nov. 1918, pp. 246-250. Discusses composition of power gas from wood and methods of obtaining largest amounts of most effective components.

PUMPS

Motor-Driven Pumps

High Efficiencies Shown by Motor-Driven Water Works Pumps at St. Paul, Minn. Mun. & County Eng., vol. 55, no. 6, Dec. 1918, pp. 202-204, 2 figs. Results obtained from tests of two 12-in. centrifugal pumps.

REFRACTORIES

Classification

Refractories. Clay-Worker, vol. 70, no. 6, Dec. 1918, pp. 504-505. Reasons for classification into acid, basic and neutral: construction, effectiveness and uses of each of these classes; properties of some refractory clays.

Firebrick

How Slag Temperatures Affect Firebrick, Raymond M. Howe. Iron Trade Rev., vol. 63, no. 23, Dec. 5, 1918, pp. 1288-1289. Penetration of slag into brick was determined after allowing bricks, which were previously heated to required temperature, to retain in cavity 35 grams of slag for 2 hrs.; tables given for various temperatures. Paper before Refractories Mfrs. Assn. Also Blast Furnace, vol. 6, no. 12, Dec. 1918, pp. 484-485.

Silica

Silica Refractories, Donald W. Ross. Jl. Am. Ceramic Soc., vol. 1, no. 7, July 1918, pp. 477-499, 6 figs. and (discussion) pp. 499-501. Experimental data on raw materials, manufacture and burning of silica brick, and properties of burned ware.

REFRIGERATION

Ammonia

What Becomes of the Ammonia in Refrigerating Systems? George L. Reuschline. Am. Soc. Refrig. Engrs. Jl., vol. 5, no. 3, Nov. 1918, pp. 161-167. Production of ammonia from normal sources; amount used in ice and refrigerating plants; actual needs and unavoidable losses; actual ammonia loss per ton of ice made; avoidable losses and how to stop them; purging; piston-rod leakage; bonus system.

Ammonia, Compression System

The Ammonia Compression Refrigerating System—XXV, W. S. Doan. Refrig. World, vol. 53, no. 12, Dec. 1918, pp. 33-34, 1 fig. Testing of lubricating oil; petroleum oils; necessary quantity to feed bearings. (To be continued.)

Ammonia Piping

Discussion of the Topic—Size of and Proper Vapor Velocity in Ammonia Suction and Discharge Mains. Am. Soc. Refrig. Engrs. Jl., vol. 5, no. 2, Sept. 1918, pp. 120-124, 1 fig. Discussion at Milwaukee meeting.

CO_2 Machine

The Carbonic Anhydride Refrigerating Machine, Peter Neff. Am. Soc. Refrig. Engrs. Jl., vol. 5, no. 3, Nov. 1918, pp. 153-156. Items of design requiring research before a CO_2 machine can be developed as successfully as one of the ammonia type.

Forecooling

Discussion of the Topic—Advantages of Forecooling Liquid Ammonia Between Receiver and Expansion Valve with Coldest Water Available. Am. Soc. Refrig. Engrs. Jl., vol. 5, no. 2, Sept. 1918, pp. 125-130. Discussion at annual meeting, New York.

Household Refrigerating Machine

The Household Refrigerating Machine, John E. Starr. Am. Soc. Refrig. Engrs. Jl., vol. 5, no. 3, Nov. 1918, pp. 157-160. Attributes difficulty of designing commercial type of small compression machine to leakage at stuffing box, small quantity of liquid circulated per minute and gradual projection of lubricant from high-pressure to low-pressure side.

Ice Manufacture

Ice Plant Investments, George. E. Wells. Am. Soc. Refrig. Engrs. Jl., vol. 5, no. 3, Nov. 1918, pp. 145-152. Detailed ice-manufacturing costs in 1915 of 20 southwestern ice plants using Corliss steam engines.

Power and Labor Requirements of Detroit Type Ice Plant, Donald Cole. Am. Soc. Refrig. Engrs. Jl., vol. 5, no. 2, Sept. 1918, pp. 110-115 and (discussion) pp. 115-119. Operation of electrically driven raw-water plant, low-pressure, drop-pipe system having in conjunction an ice storage house holding full output of thirty to one hundred days.

Motor Driven Raw Water Ice Plant, George E. Chamberlin. Am. Soc. Refrig. Engrs. Jl., vol. 5, no. 2, Sept. 1918, pp. 87-109, 11 figs. Description of electrically driven high-pressure plant making 120 tons of ice per day.

Low-Temperature Compression System

The Low-Temperature Compression System in Practice, H. Sloan. Power, vol. 48, no. 25, Dec. 17, 1918, pp. 896-987, 2 figs. From paper before Am. Soc. of Refrig. Engrs., Milwaukee.

RESEARCH

British

National Laboratory for Industrial Research, Richard T. Glazebrook. Contract Rec., vol. 32, no. 47, Nov. 20, 1918, pp. 924-926. Need of special laboratories for research work; research for trade associations; study of industrial problems in central laboratory. From lecture delivered at Royal Instn.

Science and the Future, A. A. Campbell Swinton. Machy. Market, no. 944, Dec. 6, 1918, pp. 19-20. From address to Roy. Soc. Arts.

National Research Council, U. S.

The Engineering Work of the National Research Council, Henry M. Howe. Bul. Am. Inst. Min. Engrs., no. 144, Dec. 1918, pp. 1715-1719. Purpose, status in October, 1918, and character of researches on pyrometry and electric welding.

STANDARDS AND STANDARDIZATION

Engine-Testing Forms

Standard Engine Testing Forms. Jl. Soc. Automobile Engrs., vol. 3, no. 6, Dec. 1918, pp. 378-381, 3 figs. Four sheets: one giving rules and direction for use of forms and three providing means for giving information regarding engine conditions of test and plotting curves of results.

Gasoline

Government Standard Gasoline and Oil Specifications. Jl. Soc. Automotive Engrs., vol. 3, no. 6, Dec. 1918, pp. 405-406. Specifications for aviation gasoline, motor gasoline, and fuel, gas and bunker oils, adopted by Committee on Standardization of Petroleum Specifications.

Oils, Illuminating

Specifications for Illuminating Oils. Oil & Gas Jl., vol. 17, no. 31, Jan. 3, 1919, pp. 50-52. Methods of test and specifications adopted by Committee on Standardization of Petroleum Specifications. Rules were drafted with view to allow making of products from any satisfactory crude petroleum.

STEAM ENGINEERING

Boilers

Modern Boilers (Les chaudières modernes), L. Conge. Revue Générale de l'Electricité, vol. 4, no. 19, Nov. 9, 1918, pp. 715-718, 11 figs. Several French and American types are considered as usable in large central turbo-electric stations.

Feeding and Circulating the Water in Steam Boilers, John Watson. Trans. Inst. Marine Engrs., vol. 30, no. 239, Nov. 1918, pp. 225-246 and (discussion) pp. 246-264, 7 figs. Historical account of schemes evolved and experimental work undertaken; analysis of present practices in the various types of boilers; effect of mixing hot boiler water with incoming feed in proportions up to 200 per cent. boiler water.

Mechanical Department Circular No. 11, U. S. Ry. Administration, Frank McManamy. Ry. Jl., vol. 25, no. 1, Jan. 1919, pp. 21-22, 1 fig. Rules and instructions for inspection and testing of stationary boilers.

How to Design and Lay Out a Boiler—II, William C. Strott. Boiler Maker, vol. 18, no. 12, Dec. 1918, pp. 353-354, 5 figs. Calculation of proper tube expansion; purpose of beading; use of scant tube lengths; figuring "line-up." (To be continued.)

Condensers

Keeping Up Condenser Performance, Hartley LeH. Smith. Power, vol. 48, no. 25, Dec. 17, 1918, pp. 868-870, 4 figs. How to determine economy which should be obtained and how to correct causes of low vacuum.

Steam Pressure, High

High Steam Pressure and Superheat, Eskil Berg. Power, vol. 48, no. 24, Dec. 10, 1918, pp. 832-835, 3 figs. From a paper before joint meeting of Western Soc. of Engrs., Chicago Section of Am. Soc. of Mech. Engrs. and Am. Inst. of Elec. Engrs.

Turbines

Steam Turbines for Natural Steam. Power Plant Eng., vol. 22, no. 24, Dec. 15, 1918, pp. 990-993, 7 figs. Power plant at Larderello, Italy, operating large turbine units with natural steam taken from crevices and fissures in ground.

Turbine Engines for Cargo Vessels. Marine Rev., vol. 49, no. 1, Jan. 1919, pp. 31-34, 6 figs. Mechanical features of the geared drives.

Steam Turbine Progress and Possibilities. Blast Furnace, vol. 6, no. 12, Dec. 1918, pp. 481-483, 5 figs. Higher boiler pressures; intermediate steam reheating in large multiple-cylinder machines; feedwater heating; use of economizer.

The Historical Development of Steam Turbine (1). Power House, vol. 11, no. 11, Nov. 1918, pp. 311-314, 10 figs. Growth in capacity and in size of individual units during last 30 years. (To be continued.)

Valves, Balanced Slide

Balanced Slide Valve for Andrews-Cameron Steam Engine (Tiroir équilibré pour machine à vapeur système Andrews et Cameron). Génie Civil, vol. 73, no. 17, Oct. 26, 1918, pp. 333-334, 8 figs. Description of two types, one with two and other with three ports.

See also MECHANICAL ENGINEERING, *Motor-Car Engineering (Steam Vehicles).*

THERMODYNAMICS

Heat Transmission

Heat Transfer Tests of Building Materials, L. M. Arkley. Jl. Eng. Inst. Can., vol. 1, no. 8, Dec. 1918, pp. 386-393, 6 figs. Account of tests (1) to determine selection of proper materials to be used in buildings, (2) to determine effect on transfer of heat through a 12-in. hollow tile wall of laying it up, first with hollow spaces horizontal, and second with hollow spaces vertical and directly over each other, (3) to investigate heat-insulating qualities of a number of materials suitable for refrigerating rooms including built-up walls, cork walls, and ordinary building papers.

New Heat Transmission Tables, William R. Jones. Heat. & Vent. Mag., vol. 15, no. 12, Dec., 1918, pp. 36-40. Third series of tables.

WELDING

Aluminum

How to Use a "Chill" on Aluminum Welding, David Baxter. Jl. Acetylene Welding, vol. 20, no. 6, Dec. 1918, pp. 280-282, 3 figs. Method of backing up hole in aluminum crankcase with piece of heavy galvanized iron and welding across to fill hole with aluminum, the iron acting as a sort of chill.

Arc-Welding Tool

Improved Arc Welding Tool. Aerial Age, vol. 8, no. 12, Dec. 2, 1918, pp. 619-634, 2 figs. Designed to make operation of changing electrodes definite, to permit any amount of pull when electrode freezes to work and capable of operating for voluntary release.

Electric Welding

Comparisons of Processes of Electric Butt Welding, J. B. Clapper. Boiler Maker, vol. 18, no. 12, Dec. 1918, pp. 345-346. Operations

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in butt welding; transformer control; strength of butt weld; application of point and spot welding; use of resistance process.

Modern Welding by Use of Electricity. Elec. Rev., vol. 73, no. 25, Dec. 21, 1918, pp. 959-962, 3 figs. Principles of electric arc and spot welding; advantages; methods of application; recent developments; extent of field.

Some Recent Developments in Machines for Electric Spot Welding as a Substitute for Riveting, J. M. Weed. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 928-934, 9 figs. Writer claims his experiments have demonstrated that the thickness of parts to be welded is governed by capacity of apparatus available for doing the work.

Electric Welding—A New Industry, H. A. Hornor. Contract Rec., vol. 32, no. 47, Nov. 20, 1918, pp. 931-934. Status of industry; uses of alternating current; methods of welding and of testing a joint; developments. Paper before Am. Inst. Elec. Engrs.

Comparative Characteristics of Arc Welders, J. F. Lincoln. Elec. World, vol. 72, no. 24, Dec. 14, 1918, pp. 1119-1120. Discussion to bring out comparative advantages and costs of a. c. and d. c. welders.

Features of Arc Welding Development, O. A. Kenyon. Elec. Rev., vol. 73, no. 25, Dec. 21, 1918, pp. 963-965, 2 figs. Control of welding heat; selection of kind and size of electrodes; kinds of joints and their characteristics; systematic planning of welding method to be used.

The Constant-Energy Arc-Welding Set, P. O. Noble. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 938-940, 6 figs. Type of equipment designed to facilitate maintenance of a short arc and to make it difficult to continue a long one.

Electric Welding at the Erie Works, General Electric Company, H. Lemp and J. R. Brown. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 915-918, 12 figs. Applications of process to welding saws, butt-welding high-speed steel to shank of machine steel in manufacture of machine tools, and various other mechanical purposes.

A Review of Electric Arc Welding, John A. Seede. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 881-886, 10 figs. Evaluation of present practice, with special consideration of carbon electrode welding, metallic electrode welding, electrodes, fluxes, holders, a. c. arc welding, automatic welding and apparatus employed.

Inspection of Welds

Inspection of Electric Welds, O. H. Escholz. Power, vol. 48, no. 25, Dec. 17, 1918, pp. 872-873, 3 figs. Describes various tests and their efficiencies.

Inspecting Metallic Electrode Arc Welds, O. S. Escholz. Am. Drop Forger, vol. 4, no. 11, Nov. 1918, pp. 448-450, 4 figs. Comments on significance and value of visual inspection, adhesion of deposit, penetration and electrical tests.

Joints

Lloyd's Experiments on Electrically Welded Joints, H. Jasper Cox. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 864-870, 16 figs. Results concerning modulus of elasticity, approximate elastic limit, ultimate strength, ultimate elongation, alternating stresses, chemical and microscopic analysis, and strength of welds.

Non-Ferrous Metals

The Butt Welding of Some Non-Ferrous Metals, E. F. Collins and W. Jacob. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 958-961, 5 figs. Describes process said to be outcome of search for satisfactory method of connecting end rings to rotor bars of induction motor.

Oxidation

The Welding of Iron and Steel, W. H. Cathcart. Iron Age, vol. 102, no. 26, Dec. 26, 1918, pp. 1578-1583, 10 figs. Principles governing smithy and forge; effect of oxidation; use of a flux; annealing essential; conditions to be fulfilled. From article in Apr., 1918, issue of Jl. of West of Scotland Iron and Steel Inst., Glasgow.

Oxy-Acetylene Welding

Oxy-Acetylene Pipe Welding and Cutting. Gas Age, vol. 42, no. 12, Dec. 16, 1918, pp. 515-516, 5 figs. Practical suggestions on manipulation of blowpipe. (Continuation of serial.)

Handling Acetylene Welding Outfits, E. Wanamaker. Ry. Rev., vol. 63, no. 25, Dec. 21, 1918, pp. 869-871. Discussion of acetylene and oxygen gases and instructions for handling outfits in shops. Paper before Ry. Fire Prevention Assn., Chicago.

Research

Research in Spot Welding of Heavy Plates, W. L. Merrill. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 919-922, 7 figs. Record of experiments with specially built welding machine of 36 tons pressure capacity and 100,000 amperes current capacity, showing probability that new field of application for spot welding will be developed.

Structure of Iron

Microstructure of Iron Deposited by Electric Arc Welding, George F. Comstock. Bul. Am. Inst. Min. Engrs., no. 145, Jan. 1919, pp. 43-50, 10 figs. From microscopic examination of a weld writer concludes that pale crystals typical of steel fusion welds are not cementite or martensite or any similar carbide product, but probably nitride of iron. Discussion of S. W. Miller's paper. (Bul. A. I. M. E., Feb.-May, 1918.)

A Study of the Joining of Metals, J. A. Capp. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 947-956, 36 figs. Microscopic study of welds made (1) with high current applied for long periods, (2) smaller current applied for shorter time, and (3) current just large enough to procure welding temperature when applied for minimum time; made to determine best practice in making butt welds by Thompson electric welding machine.

The Metallurgy of the Arc Weld, W. E. Ruder. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 941-946, 15 figs. Notes based on microscopical examination of crystal structure, gas holes, slag inclusions, impurities, and composition.

Tank Manufacture

Electric Arc Welding in Tank Construction, R. E. Wagner. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 899-911, 35 figs. Qualifications of successful operator; value of intelligent study of work in hand and its preparation for welding; application of arc welding to tank construction; tabular data for determining cost of process.

Welded Seams

Welded Seams Correct Faults in Converters. Boiler Maker vol. 18, no. 12, Dec. 1918, pp. 347-348, 6 figs. Experiments on welded-type heaters; difficulties in welding materials of varying thicknesses; automatic cutting machine. From Jl. Acetylene Welding.

Welding

Principles and Practices of Fusion Welding, S. W. Miller. Am. Soc. Refrig. Engrs. Jl., vol. 5, no. 3, Nov. 1918, pp. 168-215, 83 figs. Differences between various systems; principles of successful welding; composition of weld; testing welds; welding practices and materials; metallurgy and heat treatment of welds; variety of welds.

See also ELECTRICAL ENGINEERING, Transformers, Converters, Frequency Changers (Welding, Transformers for); MARINE ENGINEERING, Yards (Welding); RAILROAD ENGINEERING, Shops (Welding).

VARIA

Metric System

Reflexions on the Arguments For and Against the Metric System (Reflexions sur les pour et les contre du système métrique), Ch. Ed. Guillaume. Industrie Electrique, year 27, no. 624, June 25, 1918, pp. 225-227. Question of fundamental units; decimalization; possible adoption by Anglo-Saxon nations; arguments based on present situation. Remarks on Atkinson's communication to Instn. Elec. Engrs.

Opportunities for Engineers

Broader Opportunities for the Engineer, Charles T. Main. Jl. Am. Soc. Mech. Engrs., vol. 41, no. 1, Jan. 1919, pp. 6-11. Fields of activity opened to engineering societies and individual engineers in consequence of technical and social opportunities which have been created with the advent of world peace. Presidential address delivered at annual meeting of the Society.

Packing, Machinery

The Problem of Packing. Cassier's Eng. Monthly, vol. 54, no. 5, Nov. 1918, pp. 257-262, 6 figs. Suggestions in regard to packing machinery for home market and export.

Society Engineering

Aims and Organization of the Society, L. C. Marburg. Jl. Am. Soc. Mech. Engrs., vol. 41, no. 1, Jan. 1919, pp. 12-15. Relations of the mechanical engineer to his work, to the community and other engineers. Report of Committee on Aims and Organization of the Society.

Technical Writing

Obtaining Ideas for Technical Articles, Albert M. Wolf. Wis. Engr., vol. 23, no. 2, Nov. 1918, pp. 40-41. Value of observation and diligent application of mental faculties to gathering technical data.

Electrical Engineering

ELECTROPHYSICS

A. C. Circuits

The Calculation of Alternating Current Circuits, Gordon Kribs. Power House, vol. 11, no. 11, Nov. 1918, pp. 318-321, 2 figs. Tables of constants offered as readily usable in computing size of wire in a. c. 25- and 60-cycle circuits.

Harmonic Analysis

Harmonic Analysis of Alternating Currents by the Resonance Galvanometer (Sur l'analyse harmonique des courants alternatifs par le galvanomètre de résonance), André Blondel. Comptes rendus des séances de l'Académie des Sciences, vol. 167, no. 20, Nov. 11, 1918, pp. 711-717, 1 fig. Characteristics of method proposed as modification of Pupin's and Armagnat's. Considers (1) non-inductive resistances in circuits of galvanometer, and (2) a circuit having one or several capacities in series.

Spark-Plug Insulators

Resistance of Hot Spark Plug Insulators, R. H. Cunningham. Automotive Indus., vol. 39, no. 22, Nov. 28, 1918, pp. 907-911, 8 figs. Experimental tests to determine loss of resistance at working temperatures; how such loss affects action of plug.

Vapor Arcs

Low-Voltage Arcs in Metallic Vapours, J. C. McLennan. Proc. Phys. Soc., Lond., vol. 31, no. 176, Dec. 15, 1918, pp. 30-48, 6 figs. Repetition of experiments by Millikan and Hebb whose results writer believes to be in conflict with quantum theory. Results showed that quantum relation holds good with moderately heated incandescent cathodes and a moderate supply of metallic vapor. It was possible to obtain questioned phenomena, however, by increasing temperature of incandescent cathode.

ELECTROCHEMISTRY

Copper Plating

Automatic Copper Plating, Joseph W. Richards. Bul. Am. Inst. Min. Engrs., no. 145, Jan. 1919, pp. 27-31, 4 figs. Patented process. Basic principle involved lies in application of plating copper while iron sheet is cold and then melting metal under conditions favorable to formation of plating.

FURNACES

Electric Furnace Improvements During 1918, A. V. Farr. Blast Furnace, vol. 7, no. 1, Jan. 1919, pp. 20-24, 9 figs. Efforts to increase output; linings, tilting apparatus and cooling; power supply; comparative data.

Electrodes

Electrodes for Electric Furnaces: Their Manufacture, Properties, and Utilization (II), Jean Escard. Gen. Elec. Rev., vol. 21, no. 11, Nov. 1918, pp. 781-792, 37 figs. Form, dimensions, grouping, and composition of electrodes, and their arrangement in the various types of furnaces; life, wear, and protection of electrodes; electrode holders, cooling systems, and methods of attaching connections. Translated from Le Génie Civil.

Industrial Furnaces

Electric Heated Industrial Furnaces, George J. Kirkgasser. Indus. Management, vol. 57, no. 1, Jan. 1919, pp. 26-32, 14 figs. Type of furnaces and accessory apparatus used in melting irons, brasses and bronzes in foundries; for heat-treating metal parts; in the manufacture of special alloys; for annealing, hardening and tempering tools; and for determining decalescent and recalescent points in tool steels.

Nitrogen-Fixation Furnaces

Nitrogen Fixation Furnaces, E. Kilburn Scott. Gen. Elec. Rev., vol. 21, no. 11, Nov. 1918, pp. 793-804, 16 figs. Salient points of difference between electric furnaces for fixation of nitrogen and those for metallurgical purposes. Discussion of various features in operation, such as phase balance, starting, losses, electrodes, stabilizing arc, power factor, air supply, preheater, absorption, cooling the gas, and theory of reaction. Abstract of paper before Electrochemical Soc.

Steel Furnaces

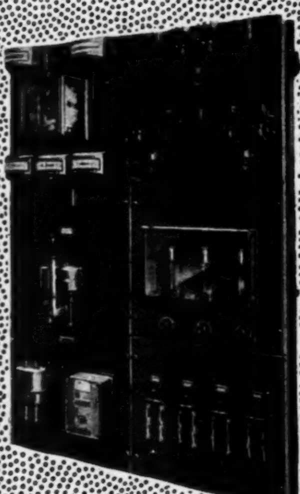
The Status of the Electric Steel Industry, Edwin F. Cone. Iron Age, vol. 103, no. 1, Jan. 2, 1919, pp. 60-62. United States still leads in output with 287 furnaces; progress since 1910; furnaces in world's industry probably over 815.

Electric Furnaces for the Production of Steel and Ferro-Alloys, J. O. Seede. Gen. Elec. Rev., vol. 21, no. 11, Nov. 1918, pp. 767-780,

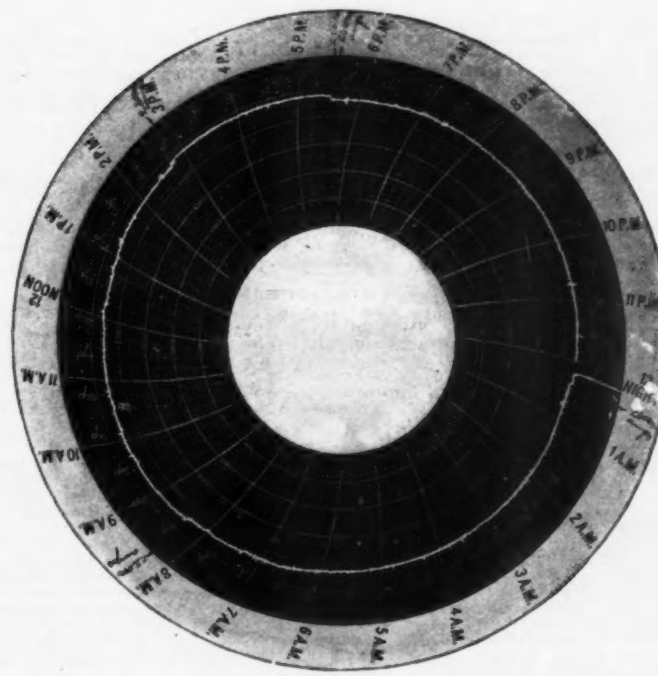
G-E Control Equipment for Electric Arc Furnaces

Abrasives, carbides and ferro-alloys are most efficiently produced in electric arc furnaces having close power input regulation.

ELECTRIC FURNACE TRANSFORMER



PRIMARY AND SECONDARY CONTROL



The above chart shows why G-E control equipment gives the greatest output of alloys per kilowatt hour input and how closely the power input to a large calcium carbide furnace was regulated by a G-E automatic control equipment. Twelve of these regulators are now being installed in the great Nitrate Plant now under erection by the Air Nitrates Corporation.

For further details consult the nearest local office of this company. District offices are listed below, local offices are in all large cities.

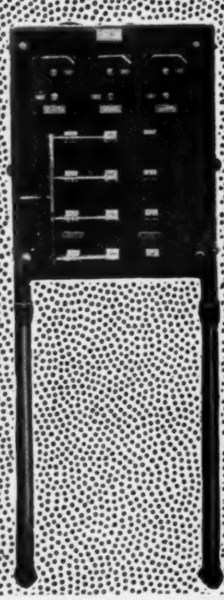
43-71

General Electric Company

General Office: Schenectady, N. Y. **District Offices in:**

Atlanta, Ga. Chicago, Ill. Boston, Mass. Cincinnati, Ohio San Francisco, Cal. New York, N. Y. St. Louis, Mo. Denver, Colo. Philadelphia, Pa.

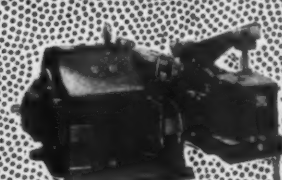
Sales Offices in all Large Cities



AUXILIARY ELECTRODE REGULATING PANEL

MOTOR-GENERATOR SET

ELECTRODE MOTOR



TILTING MOTOR

28 figs. Fundamentals of high-grade steel manufacture; author prefers electric furnace to all other types; classification and sketches of important furnaces.

Adds Electric Unit to Melting Equipment. Iron Trade Rev., vol. 63, no. 24, Dec. 12, 1918, pp. 1353-1354, 10 figs. Installation in which power is supplied through bank of two single-phase, 500-kva. transformers connected to a 2300-volt, 3-phase, 60-cycle supply line. Furnace hearth acts as neutral electrode, bottom connection being made to central point on transformer. Arcs are formed independently of one another.

Electric Furnaces in Metallurgy. Elecn., vol. 81, no. 2113, Nov. 15, 1918, pp. 588-590, 7 figs. Description of Héroult furnace.

The Electric Furnace in the Grey Iron Foundry. Can. Foundryman, vol. 9, no. 12, Dec. 1918, pp. 291-292 and 295, 4 figs. Work being done by Bowmanville Foundry Co. Mechanical features and electrical control of furnace.

Electric Furnace Data for Ferro-Tungsten, Robert M. Kenney. Blast Furnace, vol. 6, no. 12, Dec. 1918, pp. 486-487. Data and description of ferro-tungsten production; smelting of ferberite concentrate; possibilities of making in one single operation ferro-tungsten containing less than one per cent carbon. Paper before Am. Inst. Min. Engrs.

GENERATING STATIONS

Canada

Electric Power Generation in Ontario on Systems of Hydro-Electric Power Commission, Arthur H. Hull. Can. Engr., vol. 35, no. 25, Dec. 19, 1918, pp. 532-533. Details of generation and electrical distribution: Rideau and Niagara systems: Queenstown development. (Concluded.)

Centralization of Power

Wholesale Power, F. P. Royce. Stone & Webster Jl., vol. 23, no. 5, Nov. 1918, pp. 357-360. Conditions favorable to centralization of electric power. Memorandum of statement made at meeting of New England Section of Nat. Elec. Light Assn.

Hydroelectric Stations

Electric Power Generation in Ontario on Systems of Hydro-Electric Power Commission, Arthur H. Hull. Can. Engr., vol. 35, no. 24, Dec. 12, 1918, pp. 520-523. Paper before Toronto Section Am. Inst. Elec. Engrs. Also Elec. News, vol. 27, no. 23, Dec. 1, 1918, pp. 25-29, 1 fig. General plan and particulars of canal development work and power generation.

The Present Status of Hetch Hetchy, Rudolph W. van Norden. Jl. Elec., vol. 41, no. 10, Nov. 15, 1918, pp. 438-443, 8 figs. Survey, scope and present progress of water and power project undertaken by city of San Francisco.

Data Existing in Regard to the Construction of Hydroelectric Power Plants (Sur les données actuelles en matière de construction d'usines hydroélectriques), Denis Eydoux. Annales des Ponts et Chaussées, year 88, vol. 4, no. 18, Jul-Aug. 1918, pp. 7-96, 34 figs. Résumé of theoretical considerations, general equations and present practice, with special reference to groups of French plants in Dauphiné and the arrangement existing between water-courses of the Société Pyrénéene (Toulouse and Tarn) with those of the Société Meridionale (Aude and Hérault). (To be continued.)

Steam-Electric Stations

A Good Instance of Utilization of Italian Products in Argentine (Uno forte impronta dei produttori italiani nell' Argentina). L'Industria, vol. 32, no. 21, Nov. 15, 1918, pp. 638-644, 13 figs. Details and plans of steam-turbine central station distributing 30 million kw.hr. at 7000 volts to five substations. Substation also described.

GENERATORS AND MOTORS

Dynamical Theory

The Dynamical Theory of Electric Engines, Elecn., vol. 81, no. 2114, Nov. 22, 1918, pp. 616-617, 4 figs. Abstracted from 10th Kelvin lecture delivered by L. B. Atkinson before Inst. of Elec. Engrs.

Alternators

High-Frequency Alternators (Les alternateurs à haute fréquence), O. Billeux. Revue Générale de l'Electricité, vol. 4, no. 21, Nov. 23, 1918, pp. 803-805, 5 figs. Principles of these machines, particularly of the Alexanderson type (frequency, 30,000 per sec.), built for experimental purposes.

Generators

Construction and Use of Generators Driven by Waterwheels. Elec. Rec., vol. 24, no. 6, Dec. 1918, pp. 60-66, 24 figs. Important features in both vertical and horizontal types.

Induction Motors

Reconnecting Induction Motors—For Change in the Number of Poles, A. M. Dudley. Power, vol. 49, no. 1, Jan. 7, 1919, pp. 9-14, 15 figs. (Third article.)

Rotors

Turbo-Alternator Rotors: Features of Mechanical Design (II), S. F. Barclay. Power House, vol. 11, no. 11, Nov. 1918, pp. 323-327, 17 figs. Suggested specifications for guidance in purchasing equipment.

Synchronous Motors

Magnetization Curves for Synchronous Motors (Fältkurvor-diagram och magnetiseringskurvor for flerfasiga synkronmaskiner), John Wennerberg. Teknisk Tidskrift, Elektroteknik, vol. 48, no. 11, Nov. 6, 1918, pp. 138-146.

LIGHTING AND LAMP MANUFACTURE

Fixtures

Linking Science and Art in Lighting, M. Luckiesh. Elec. Rev., vol. 73, no. 23, Dec. 7, 1918, pp. 884-885. Suggestions for fixture dealer in demonstrating lighting effects. Third article. (First and second appeared in Elec. Rev. Oct. 5 and Nov. 2.)

Lamps, Manufacture

Methods of Manufacturing Incandescent Lamps, H. M. Robins. Wis Engr., vol. 23, no. 3, Dec. 1918, pp. 67-76, 6 figs. Description of required operations with reference to advantageous working conditions of manufacturing establishments.

Light Generation and Distribution

Light, Electricity and the Shop, C. E. Clewell. Am. Mach., vol. 49, no. 24, Dec. 12, 1918, pp. 1061-1065, 10 figs. From coal pile to machine tool and lamp, losses are considered.

MEASUREMENTS AND TESTS

Loader

The Loader, Ross B. Mateer. Jl. Elec., vol. 41, no. 12, Dec. 15, 1918, p. 553, 4 figs. Suggests composite symbol to indicate load center, density and character of load served.

Meters

Three-Wire D-5 Meters. Jl. Elec., vol. 41, no. 10, Nov. 15, 1918, pp. 474-475. Wiring diagram and features of watthour meter consisting of two- and three-wire elements placed side by side in common base and registering on common recording train so that sum of revolutions of both elements will be added and indicated on dial.

Power-Factor Indicators

Removing Obstacles to Power-Factor Charge, Will Brown. Elec. World, vol. 72, no. 26, Dec. 28, 1918, pp. 1220-1222, 1 fig. Necessity of standard method of measuring power factor and instrument that would be universally applicable; examination into methods now employed in widely separated plants.

Calibration of Power Factor Indicators, Walter Wescott Hoke. Elec. World, vol. 72, no. 23, Dec. 7, 1918, pp. 1076-1078, 4 figs. Method of calibrating polyphase power-factor indicators of which resistances of potential circuits are not equal; also applies to indicators in which current coil is in one phase of a two-phase line.

Rubber-Goods Testing

Safeguarding Electrical Employees. Elec. World, vol. 72, no. 26, Dec. 28, 1918, pp. 1223-1226, 5 figs. How companies which take active interest in well-being of their employees have made use of protective devices to guard against personal injuries; care and testing.

Transmission Factor for Glass

The Measurement of Transmission-Factor, M. Luckiesh and L. L. Mellor. Jl. Franklin Inst., vol. 186, no. 5, Nov. 1918, pp. 529-545, 8 figs. Investigation of various arrangements of apparatus designed to determine transmission factors for several diffusive glasses for illumination (1) by a narrow beam of light directed perpendicularly to surface of specimen, and (2) uniformly diffused light reaching specimen from all directions; examination of effect on value of transmission factor of position of specimen with respect to light and character of side, smooth or rough, upon which light strikes it.

POWER APPLICATIONS

Alloy Production

New Materials Developed in Germany for Electrical Industry (Les nouveaux materiaux dans l'industrie electrique en Allemagne). S. Frid. Industrie Electrique, year 27, no. 624, June 25, 1918, pp. 227-250. Application of alloys such as electron (10 Al + 90 Mn), magnalium, duralumin and other compositions; regulation governing material to be used in various types of electric lines; instruments and apparatus; machines and transformers.

Dairy Farms

Use of Electricity on Dairy Farms to Increase Production. Elec. Rev., vol. 73, no. 26, Dec. 28, 1918, pp. 995-997, 3 figs. Proper lighting and use of electric fans in Georgia farm stables result in greater quantity and better quality of product.

Electrochemical Processes

Electricity Releases Chemistry's Power, James M. Matthews. Gen. Elec. Rev., vol. 21, no. 11, Nov. 1918, pp. 727-750, 46 figs. Some of the uses of electricity in the chemical industry are illustrated with descriptions of uses of electric furnaces and electrically-driven motors and installations of electrolytic works.

Electrolytic and Electrothermic Processes and Products. Gen. Elec. Rev., vol. 21, no. 21, no. 11, Nov. 1918, pp. 756-766, 12 figs. Brief outline of manufacture of sodium, calcium, magnesium and aluminum; more detailed description of electric-furnace methods of manufacturing calcium carbide, carborundum, silicon, graphite, alundum, fused silica and carbon bisulphide; methods of fixation of atmospheric nitrogen and oxidation of nitrogen; sketches of Birkland-Eyde, Schonherr, and Pauling furnaces.

Gold Dredges

Use of Electricity on Gold Dredges. Elec. Rev., vol. 73, no. 23, Dec. 7, 1918, pp. 881-883, 3 figs. Description of typical dredge; value of central-station service for work; points to observe in selecting apparatus required; description of electrical equipment used.

Harbors

Extensive Use of Electricity for San Francisco Harbor. Elec. Rev., vol. 72, no. 26, Dec. 26, 1918, pp. 1001-1005, 4 figs. Pier, dock and street lighting; electric clock system; harbor lights and fog signals; fire-alarm and telephone system; electric repair and maintenance service; features of wiring.

Shipbuilding

The Application of Electricity in Ships and Shipbuilding, J. F. Nielson. Elecn., vol. 81, no. 2114, Nov. 22, 1918, pp. 621. Abstract of paper before Scottish Local Section of Inst. of Elec. Engrs., Nov. 1918.

Steel Mills

Operating Electrically-Driven Steel Mills, J. T. Sturtevant. Iron Trade Rev., vol. 63, no. 23, Dec. 5, 1918, pp. 1292-1293, 4 figs. Layout, equipment, power consumption, tonnages and capacities of 11 installations at Lehigh plant of Bethlehem Steel Co.

TELEGRAPHY AND TELEPHONY

Antenna

The Vertical Grounded Antenna as a Generalized Bessel's Antenna, A. Press. Proc. Inst. Radio Engrs., vol. 6, no. 6, Dec. 1918, pp. 317-322, 1 fig. General expression for current at any point of antenna formulated by taking account of variable distribution of inductance and capacity; particular solution for current and voltage distribution in case of antenna having zero current at top and maximum current at bottom.

Capacity of a Horizontal Antenna (Capacité d'une antenne horizontale), J-B Pompey. Revue Générale de l'Electricité, vol. 4, no. 21, Nov. 23, 1918, pp. 790-792, 1 fig. Modification of original derivation of Pedersen's formula.

Duplex Polar Transmission

Improving Polar Duplex Transmission. Telegraph & Telephone Age, no. 24, Dec. 16, 1918, pp. 564-565, 5 figs. Diagrams of five different schemes tried in long lines operated polar duplex.

Photographs, Wireless Transmission of

The Design and Construction of Apparatus for the Wireless Transmission of Photographs, Marcus J. Martin. Wireless World, vol. 6, no. 69, Dec. 1918, pp. 509-513, 7 figs. Describes system outlined in handbook on the Wireless Transmission of Photographs as at present developed. Writer's intention is to provide practical groundwork for improvements. (To be continued.)

Radio Telephony

Some Aspects of Radio Telephony in Japan, Eitaro Yokoyama. Wireless World, vol. 6, no. 69, Dec. 1918, pp. 484-487, 5 figs. Influence of gas clearance, dimensions and shape of electrodes upon discharge. From Proc. Inst. Radio Engrs. (Continuation of serial.)

Radio Transmitter

On the Electrical Operation and Mechanical Design of an Impulse Excitation Multi-Spark-Group Radio Transmitter, Bowden Washington. Proc. Inst. Radio Engrs., vol. 6, no. 6, Dec. 1918, pp. 295-315, 31 figs. Discussion of

impulse excitation; description of three forms of gaps suitable for extreme quenching; oscillograms showing operation of such gaps; operation of actual 0.5-kw. and 2-kw. sets.

Spark Discharges

The Revolving Mirror and Spark Discharges, Lindlay Pyle. Wireless World, vol. 6, no. 69, Dec. 1918, pp. 489-490, 1 fig. Shows diagrammatically and describes briefly method of observing and photographing oscillatory nature of "wireless" spark. From Electrical Experimenter.

Spark Gap

A Ventilated Spark Discharge Gap. Wireless Age, vol. 6, no. 3, Dec. 1918, pp. 44-45, 3 figs. Internal construction and action of apparatus said to be silent in operation and to maintain a predetermined operating characteristic.

On the Possibility of Tone Production by Rotary and Stationary Spark Gaps, Hidetsugu Yagi. Proc. Inst. Radio Engrs., vol. 6, no. 6, Dec. 1918, pp. 323-343, 17 figs. Results produced by needle and spherical gaps with a. c. transformer, spark-gap method and with high-tension d. c. spark-gap method; brief treatment of transient conditions existing before establishment of stable tone régime.

Telephone, Sound-Detecting Devices

Telephone Service Standards. Telephony, vol. 76, no. 1, Jan. 4, 1919, pp. 22-23. Investigation of service and transmission standards and experimental work on sound-detecting devices by telephone section of Bureau of Standards, from 1917-1918 report Secretary of Commerce.

Telephone Troubles

How to Locate Telephone Troubles, J. Bernard Hecht. Telephony, vol. 76, no. 1, Jan. 4, 1919, pp. 26-27. Care and maintenance of primary batteries. Instructions to managers, wire chiefs and troublemen of local battery telephone exchanges. Sixth article.

Vacuum-Tube Electrodes

A Method of Constructing Gas-Free Electrodes. Wireless World, vol. 6, no. 69, Dec. 1918, pp. 488-489. Process of manufacturing vacuum tube in which anode consists of coating of metal sprayed on inside of bulb by incandescing refractory metallic conductor, such as tungsten, in partial vacuum. From Wireless Age.

Time Signaling

Wireless Time-Signaling Device, Wireless Age, vol. 6, no. 3, Dec. 1918, pp. 13-14, 3 figs. Apparatus for synchronizing time clocks from one main radio station, permitting at predetermined intervals a correction of errors encountered in clock mechanisms.

TRANSFORMERS, CONVERTERS, FREQUENCY CHANGERS

Radio Frequency Changers

Radio Frequency Changers, E. E. Bucher. Wireless Age, vol. 6, nos. 3 and 4, Dec. 1918 and Jan. 1919, pp. 20-22 and 20-22, 13 figs. Reported progress in their application to wireless telegraphic and telephonic communication. Control of antenna currents.

Rectifiers

Incandescent-Cathode Arc Device for the Rectification of Alternating Currents. Wireless Age, vol. 6, no. 3, Dec. 1918, pp. 14 and 43-44, 3 figs. Construction and electrical connections of tube; arc started by means of a high-voltage discharge from a pointed cathode.

An Enclosed Rectifier. Wireless Age, vol. 6, no. 3, Dec. 1918, pp. 12-13, 3 figs. Incandescent cathode type. Argon at considerable pressure is injected into enclosed medium.

Rotary Converters

The Effect of Power-Factor on Output of Rotary Converters with Reactance Control, R. G. Jakeman. Elecn., vol. 81, no. 2114, Nov. 22, 1918, pp. 614-616, 4 figs. Dealing with effect of power-factor on size of converter.

Transformer Dimensions

Dimensions of Transformers, A. R. Low. Elecn., vol. 81, no. 2113, Nov. 15, 1918, pp. 597-599. Object of article is to classify principal problems of transformer discussion and compare certain assumptions, methods and results.

Transformer Oil

Transformer Oil. W. S. Flight. Elecn., vol. 81, no. 2115, Nov. 29, 1918, pp. 636-638, 4 figs. Author discusses types and characteristics of oils; formation of sludge; minor tests.

Welding, Transformers for

Transformers for Electric Welding, W. S. Moody. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 935-937. Requirements of those used for spot welding and for arc welding; construction found best to fulfill service specifications of each type.

See also ELECTRICAL ENGINEERING, Transmission, Distribution, Control (Transformer Losses).

TRANSMISSION, DISTRIBUTION, CONTROL

Central-Station Service

Twenty-Seven Thousand Dollar Saving in Manhattan Building Plant. Power, vol. 48, no. 26, Dec. 24, 1918, pp. 918-919. By using Edison off-peak service during summer months, substituting motor-driven elevator pumps for inefficient steam pumps, installing a feedwater heater and a stoker.

Frequency Control

Better Frequency Control, Henry E. Warren. Gen. Elec. Rev., vol. 21, no. 11, Nov. 1918, pp. 816-819, 3 figs. Method which records revolutions, thus indicating mean frequency and enabling operator to adjust governor-regulating mechanism to maintain average frequency at its normal value practically exact.

Growth of Electric Systems

The Growth of Electric Systems, Julian C. Smith. Can. Engr., vol. 35, no. 25, Dec. 1918, pp. 539-540. Evolution since 1882: direct and alternating transmission systems; why the "hydro" is 25 cycles; thrust bearings and vertical units. From one of the J. E. Aldred lectures on engineering practice, Johns Hopkins University.

Interconnection

Interconnection of Power Systems. Proc. Am. Inst., Elec. Engrs., vol. 37, no. 12, Dec. 1918, pp. 1207-1333, 12 figs. Technical features of interconnection of electric power systems of California; electric power in northern and central California; function of Pacific Gas and Electric Co. in interconnected operation of power companies of central and northern California. Symposium at meeting of San Francisco Section Am. Inst. Elec. Engrs.

Power Factor

Location for Power-Factor Corrective Apparatus, Will Brown. Elec. World, vol. 72, no. 24, Dec. 14, 1918, pp. 1125-1128, 3 figs. Experience with static condensers; dissimilarities in synchronous machines; using idle alternators as condensers; best motor rating for correction; effect of condenser location on result.

Improvement of Power-Factor by the Operation of Synchronous Motors (Note sur l'emploi des moteurs synchrones pour améliorer le facteur de puissance), Paul Rieunier. Revue Générale de l'Electricité, vol. 4, no. 21, Nov. 23, 1918, pp. 771-788, 15 figs. Mathematical and graphic study of equation, $S\ R = \sin \Phi_1 - \cos \Phi_1 \tan \Phi_2$, where S is current supplied in quadrature by synchronous motor, R current absorbed by network with factor power $\cos \Phi_1$ and Φ_1, Φ_2 are the respective phase angles before and after motor is connected. Practical applications are deduced.

St. Lawrence River Transmission Line

111,000-Volt Transmission Line Over the St. Lawrence River, S. Svenningson. Elec. News, vol. 27, no. 23, Dec. 1, 1918, pp. 31-34. Crossing consists of central span 4801 ft. long supported by two 350-ft. towers. Author gives special attention to cables, insulators, ice protection and sag calculations. Paper before Toronto meeting of Am. Inst. Elec. Engrs.

Substations

Effect of a Tie-Line Between Two Substations, H. B. Dwight. Elec. Rev., vol. 73, no. 25, Dec. 21, 1918, pp. 966-968, 1 fig. Methods of calculating effect of tie-lines upon current and voltage; several formulæ given.

The Modern Outdoor Substation, M. M. Samuels. Elec. World, vol. 72, no. 23, Dec. 7, 1918, pp. 1068-1073, 20 figs. Apparatus developed until it is as reliable as indoor equipment; station design not greatly improved; notes on transformers, oil circuit breakers, lightning arresters, air-break switches and bus supports.

A Two-Unit Automatic Substation, Walter C. Slade. Elec. Ry. Jl., vol. 52, no. 24, Dec. 14, 1918, pp. 1038-1044, 13 figs. Description of Rhode Island Co.'s substation at Oakland illustrating latest practice. Economics of automatic substation application.

Synchronous Condensers

Synchronous Condenser in Fuel Conservation, L. N. Robinson. Jl. Elec., vol. 41, no. 10, Nov. 15, 1918, pp. 456-458, 2 figs. Possibilities due to quadrature phase relation of energy and wattless components of current in virtue of which a synchronous condenser can deliver, under given line regulations, wattless current corresponding to 10,000-kv-a, and simultaneously absorb as motor or deliver as generator 10,000 kw. with total current corresponding to only 14,100 kv-a.

Transformer Losses

Influence of Distributing System on Transformer Losses in Large Networks (Pertes dans les transformateurs des grands réseaux suivant le système de distribution employé). Revue Générale de l'Electricité, vol. 4, no. 19, Nov. 9, 1918, pp. 721-724, 5 figs. Study and comparison of losses in two systems: (1) uniform distribution at 20,000 to 30,000 volts and (2) distribution at 30,000 to 50,000 volts in main network with reduction to 6,000 to 20,000 volts in secondary lines. From Electrotechnische Zeitschrift.

See also ELECTRICAL ENGINEERING, Generating Stations (Steam-Electric Stations).

VARIA

Battery Charging, A. C.

High-Tension Battery Fed with Alternating Current (Sur une batterie à haute tension alimentée à courant alternatif). Industrie Electrique, year 27, no. 633, Nov. 10, 1918, pp. 416-417, 1 fig. Principle and diagram of apparatus which by an arrangement of Grætz valves and condensers connected to secondary winding of transformer permits conversion of alternating current into direct current at voltages up to 10,000. From Bulletin de l'Association Suisse des Electriciens, Apr. 1918.

Contract Clauses

Power Factor Clauses in Contracts, Will Brown. Elec. World, vol. 72, no. 25, Dec. 21, 1918, pp. 1164-1165. Commercial problems involved; opinions from widely scattered central stations regarding necessity of considerating power factor; typical clauses of two types of contract which base charges on average power factor.

Electrolysis Protection

Drainage if Necessary vs. Negative Feeder Electrolysis Protection, D. W. Roper. Elec. Ry. Jl., vol. 52, no. 23, Dec. 7, 1918, pp. 1003-1007, 12 figs. Comparison of plans used in St. Louis and Chicago for eliminating damage to underground structures from power company viewpoint. (Abstract of paper before Am. Inst. Elec. Engrs., St. Louis.)

Fires in Oil Switches

R. Frère Process of Extinguishing Fires in High-Tension Oil Switches (L'extinction des feux d'huile dans les cellules d'interrupteurs à haute tension par les procédés R. Frère), Ch. Benjamin. Génie Civil, vol. 73, no. 19, Nov. 9, 1918, pp. 361-363, 10 figs. Fundamental principle of process consists in reducing oxygen in atmosphere by a large quantity of inert gas such as nitrogen.

International Electrotechnic Commission

International Electrotechnic Commission (La Comision Electrotécnica Internacional), German Niebuhr. Boletin de la Asociación Argentina de Electro-Técnicos, vol. 4, no. 8, Aug. 1918, pp. 783-788. Its origin, development and work. (To be continued.)

Lightning Arresters

Substitution of Copper for Platinum in Lightning Rods on Account of Present Shortage of Platinum (L'emploi du platine et du cuivre sur les paratonnerres et la crise du platine), E. Lignorelles. Génie Civil, vol. 73, no. 18, Nov. 2, 1918, pp. 351-353. States that aluminum, copper and iron are satisfactory for lightning rods; gives suggestions as to proper installation.

Storing Direct-Current Aluminum Arresters for the Winter, F. T. Forster. Gen. Elec. Rev., vol. 21, no. 11, Nov. 1918, pp. 820-821. Ill effects of leaving plates standing in electrolyte when arrester is out of service; method of preparing arresters for storage.

Civil Engineering

BRIDGES

Arch Bridge

The Rock Island Builds Two Rainbow Arch Bridges. Ry. Age, vol. 65, no. 23, Dec. 6, 1918, pp. 1003-1005, 4 figs. Limited-weight concrete structure with shallow floor.

Erection

Erection Experiences at the Sciotoville Bridge, Clyde B. Pyle. Eng. News-Rec., vol. 81, no. 26, Dec. 26, 1918, pp. 1182-1186, 6 figs. Machines used found efficient; adjustment of bridge easy; deflections agreed with computed values; last of three articles on field work.

Pontoon Bridge

The Sardah (India) Pontoon Bridge. Ry. Engr., vol. 39, no. 467, Dec. 1918, pp. 221-222,

6 figs. Principles of construction, method of use and structural details of 420-ft. 7-pontoon bridge. From report of Technical Section of Railway Branch, Public Works Department, Government of India.

Railway Bridges

General Specification for Steel Railway Bridges. Jl. Eng. Inst. Can., vol. 1, no. 8, Dec. 1918, pp. 367-385, 3 figs. Final draft as approved by meeting of committee of the Institute.

Reinforced-Concrete Flat Slab Railway Bridges, A. B. Cohen. Ry. Gaz., vol. 29, no. 20, Nov. 15, 1918, pp. 528-530, 2 figs. Advantages of this type and details of Lackawanna terminal at Buffalo, N. Y. Paper before joint session of Am. Concrete Inst. and Am. Soc. for Testing Materials.

Stress Measurements on Niagara Gorge Railway Bridge, Charles Evans Fowler. Eng. News-Rec., vol. 81, no. 26, Dec. 26, 1918, pp. 1172-1175, 6 figs. Permissible loading studied by strain gage; dead-load condition of arch determined by forcing crown apart and measuring release of stress.

BUILDING AND CONSTRUCTION

Barracks

Temporary Barracks at Rosedale Heights. Contract Rec., vol. 32, no. 52, Dec. 25, 1918, pp. 1019-1022, 6 figs. Disposition and finish of 24 buildings rapidly completed for Toronto demobilization depot.

Gypsum Houses

Houses of Gypsum Have Many Advantages. Contract Rec., vol. 32, no. 51, Dec. 18, 1918, pp. 1006-1007, 1 fig. Mode of constructing walls of gypsum blocks cast from gypsum mortar.

Hospitals

Details of Hospital Construction, N. V. Perry. Modern Hospital, vol. 11, no. 6, Dec. 1918, pp. 469-471, 5 figs. Remarks on general requirements, adaptable equipments for ward lighting, suitable arrangement of heating system, and special features demanded in floor construction. Paper before convention of Am. Hospital Assn.

Mills

The Reconstructed Plant of the Quaker Oats Company at Peterboro, Ont. Contract Rec., vol. 32, no. 47, Nov. 20, 1918, pp. 918-921, 6 figs. Work done in clearing site in plant destroyed by fire; layout of new buildings.

Ornamentation

Structural Ornamentation. Vol. 70, no. 6, Dec. 1918, pp. 506-507. Study in face brick, fancy brick, architectural terra cotta and decorative tile as factors in the clayworking industry.

Roofing

English Slate and Tile Roofing Methods. Metal Worker, vol. 90, no. 26, Dec. 27, 1918, pp. 703-705, 9 figs. Plain and ornamental slating; single- and double-nailing methods; hints on making repairs.

School

Test of Chicago and Cook County School for Boys, Meyer J. Sturm. Heat. & Vent. Mag., vol. 15, no. 12, Dec. 1918, pp. 41-44, 5 figs. Description of building and its equipment.

Slabs and Culverts

Practice in the Design of Concrete Floor Slabs and Flat Top Culverts, Geo. H. Tinker. Bul. Am. Ry. Eng. Assn., vol. 20, no. 210, Oct. 1918, pp. 3-19. Summary of replies from bridge engineers connected with various railroads to questionnaire in regard to their practice concerning longitudinal, transverse and vertical distribution of axle loads and impact allowance in designing culverts and slabs; a short analysis of the salient points also presented.

Timber Framing, Steel in

How to Use Steel in Timber Framing, Ernest Irving Freese. Building Age, vol. 41, no. 1, Jan. 1919, pp. 13-15, 9 figs. Practical methods of supporting long-span floors and bearing partitions upon structural-steel girders.

CEMENT AND CONCRETE

Cold-Weather Concrete

Some Temperature Records of Cold Weather Concrete, L. J. Towne. Stone & Webster Jl., vol. 23, no. 6, Dec. 1918, pp. 414-417, 3 figs. Tests made to secure data on amount of protection necessary to prevent concrete from freezing before setting can take place. On account of heat generated as result of chemical actions incident to setting concrete does not follow daily variations in air temperatures.

Compression Tests

Some Compression Tests of Portland Cement Mortars and Concrete Containing Various Percentages of Silt, Arthur C. Alvarez and James R. Shields. Univ. of Cal. Publications in Eng., vol. 2, no. 3, Nov. 19, 1918, pp. 119-130, 1 fig. Concludes that at age of 28 days the compressive strength of 1:2:4 concrete stored in water increases with increase in percentage of silt for amounts up to 14 per cent by weight of sand, and that of mortars varying in proportion between 1:1 and 1:4 is reduced on an average by about 4.5 per cent with 10 per cent silt.

Oil

Oil and Concrete. Ry. Engr., vol. 39, nos. 462 and 466, July and Nov., 1918, pp. 135-137 and 207-210. Results of laboratory tests on different specimens and under varied conditions; L. Waller Page's experiments on waterproofing concrete; W. Lawrence Gadd's conclusions from his investigation of Page's results; accounts of other experimenters. (To be continued.)

Poles

Hollow Concrete Poles Made by New Method. Ry Age, vol. 65, no. 25, Dec. 20, 1918, pp. 1127-1128, 3 figs. Important savings in weight over solid construction are effected by centrifugal process.

Study of the Construction of Latticed Girder Poles for Electrical Lines (Contributo allo studio delle palificazioni per condutture elettriche), Ettore lo Cigno. L'Elettrotecnica, vol. 5, no. 29, Oct. 15, 1918, pp. 402-407, 7 figs. Analytical investigation of stresses in latticed girder poles of square base with formulæ and graphs for examination of relative significance of mechanical coefficients.

Setting Process

The Setting Process in Lime Mortars and Portland Cements, Cecil H. Desch. Contract Rec., vol. 32, no. 47, Nov. 20, 1918, pp. 922-923. Review of researches undertaken and hypotheses advanced.

Waterproofed Floors

Waterproofed Floors for Railway Crossings Over Streets, H. T. Welty. Eng. News-Rec., vol. 81, no. 24, Dec. 12, 1918, pp. 1081-1086, 9 figs. Grade-crossing work makes severe demands; troughing unsatisfactory; concrete slab floor; methods of sealing concrete to girders.

See also CIVIL ENGINEERING, Building Construction (Slabs and Culverts); Earthwork, Rock Excavation, etc. (Dams).

EARTHWORK, ROCK EXCAVATION, ETC.

Dams

Progress on Concrete Dam at Paris, Ont. Contract Rec., vol. 32, no. 49, Dec. 4, 1918, pp. 955-956, 2 figs. Method of bracing framework.

Construction Features of a Multiple Arch Dam, L. R. Jorgensen. Jl. Elec., vol. 41, no. 11, Dec. 1, 1918, pp. 506-508, 3 figs. Considers details of construction methods with reference to an actual case.

A Veritable Niagara Created in the South—Mammoth Hydro-Electric Development in East Tennessee, Stuart Towe. Mfrs. Rec., vol. 75, no. 1, Jan. 2, 1919, pp. 143-145, 3 figs. Brief description of dam 225 ft. high, 725 ft. long at top and 350 ft. at base, 175 ft. thick at base and 12 ft. at top. For a 90,000-hp. hydro-electric development.

New Concrete Dam and Bridge Over Lynn River at Port Dover. Contract Rec., vol. 32, no. 52, Dec. 25, 1918, pp. 1031-1033, 6 figs. Excavation work; specifications for aggregate.

The Lake Eleanor Dam, Rudolph W. Van Norden. Jl. Elec., vol. 41, no. 12, Dec. 15, 1918, pp. 551-553, 4 figs. Plans, essential features and details of construction. Dam contains 11,000 cu. yd. of concrete.

HARBORS

Floating Docks

Construction and Trials of 30,000-Ton Black Sea Floating Dock. Engineering, vol. 106, no. 2759, Nov. 15, 1918, pp. 551-552, 3 figs. Drawings with principal dimensions and description.

San Francisco Harbor

Harbor Improvements at San Francisco, Charles W. Geiger. Int. Mar. Eng., vol. 24, no. 1, Jan. 1919, pp. 31-35, 7 figs. Extensive enlargement of piers; large bulkhead warehouses; railroad connection with piers; developments in Islais Creek section.

See also ELECTRICAL ENGINEERING, Power Applications (Harbors).

MATERIALS OF CONSTRUCTION

Road Materials

Standard Forms for Tests, Reports, and Method of Sampling for Road Materials. Better Roads & Streets, vol. 8, no. 8, Aug. 1918, pp. 300-306, 2 figs. From Bul. 555 issued by office of Public Roads and Rural Eng.

Stucco

Review of Stucco Tests by Bureau of Standards, J. C. Pearson. Cement & Eng. News, vol. 30, no. 12, Dec. 1918, pp. 36-37. From paper at annual meeting of Am. Concrete Inst.

MECHANICS

Arches

Calculation of Built-In Arches Under the Action of Continuous External Loads (Calcul des arcs encastrés sollicités par des charges extérieures continues), P. Ernest Flamard. Génie Civil, vol. 73, no. 11, Sept. 14, 1918, pp. 207-209, 4 figs. Mathematical study of problem with reference to work of deformation.

Beams

Beam Deflections Under Distributed or Concentrated Loading, J. B. Kommers. Eng. News-Rec., vol. 82, no. 1, Jan. 2, 1919, pp. 44-46, 10 figs. New algebraic method proposed for cases usually solved by graphical calculation gives accurate results.

Bending Moments in Grillage Beams, R. Fleming. Eng. & Contracting, vol. 50, no. 26, Dec. 25, 1918, pp. 585-586, 1 fig. Outcome of recent review of calculations for proportioning grillage beams in foundations.

Lines of Influence for a Vierendeel Beam (Lignes d'influence pour une poutre Vierendeel), G. Magnel. Génie Civil, vol. 73, no. 18, Nov. 2, 1918, pp. 344-347, 5 figs. Mathematical investigation of bending moments and other mechanical factors in reinforced-concrete beam.

ROADS AND PAVEMENTS

Boulevards

Boulevards of San Francisco, California, Charles W. Geiger. Good Roads, vol. 17, no. 1, Jan. 4, 1919, pp. 1-3, 5 figs. Notes on history and construction of scenic drives in and near city.

Concrete Pavements

Concrete Pavement Subjected to Severe Test, George C. Swan. Concrete Highway Mag., vol. 2, no. 11, Nov. 1918, pp. 246-247, 3 figs. Damage at crossing where locomotive was thrown off track and dragged itself 40 ft. over concrete surface.

Construction

Construction Methods Employed in Building Lincoln Highway Cut-Off Across the Desert at Gold Hill, Utah, R. E. Dillree. Mun. & County Eng., vol. 55, no. 6, Dec. 1918, pp. 195-197, 12 figs. Building roadway with grade above level of desert under conditions which necessitated using hay to keep heavy equipment from bogging down.

Disintegration of Roads

The Road; Its Paramount Importance as Viewed by a Briton, J. H. A. MacDonald. Mun. & County Eng., vol. 55, no. 6, Dec. 1918, pp. 218-221. Concludes necessity of building good roads from analysis of London traffic statistics and considers problem of road disintegration and that of paying for roads.

Hard-Surface Pavements

The Prevention of Longitudinal Cracks in Hard Surfaced Pavements, Wm. C. Perkins. Contract Rec., vol. 32, no. 49, Dec. 4, 1918, pp. 972-973. Suggests use of tile in artificial foundation.

Macadam Roads

The Maintenance of Macadam Roadways, R. C. Heath. Contract Rec., vol. 32, no. 52, Dec. 25, 1918, pp. 1033-1034. Preventing wear and raveling; carpet treatment; economic importance of road maintenance. Paper before Ky. Highway Engrs. Assn.

Snow Removal

Organization, Methods and Equipment Employed in Removing Snow from Main Roads in Pennsylvania, George H. Bile. Mun. & County Eng., vol. 55, no. 6, Dec. 1918, pp. 216-218. Address before Highway Traffic Assn. of N. Y. State.

Snow Removal on Trunk Line Highways, Charles J. Bennett. Mun. & County Eng., vol. 55, no. 6, Dec. 1918, pp. 214-215, 3 figs. Address before Highway Traffic Assn. of N. Y. State.

State Highways

State Highway Work in 1919. Good Roads, vol. 17, no. 1, Jan. 4, 1919, pp. 4-6. Report of available funds and plans for work in 31 states.

War, Roads During

Construction and Maintenance of Roads During War. Better Roads & Streets, vol. 8, no.

8, Aug. 1918, pp. 299 and 324. Policy issued by Council of Nat. Defence.

See also CIVIL ENGINEERING, Materials of Construction (Road Materials).

SANITARY ENGINEERING

Sewage Disposal

Sewage Disposal from an Operator's Standpoint, William K. F. Durrant. Can. Engr., vol. 35, no. 24, Dec. 12, 1918, pp. 512-513. Comments on each of features of plant consisting of detritus pit and screen chamber, pump house, plain sedimentation tanks, bacteria beds, disinfecting chambers and humuspond. Abstracted from Western Min. News.

The Private Sewerage Question, D. H. Wyatt. Clay-Worker, vol. 70, no. 6, Dec. 1918, pp. 500-501. Analysis of results produced by leaky building drains and sewers. Vitrified pipe advocated as well constituted to withstand chemical action.

The Aqua Privy. Indian Eng., vol. 64, no. 14, Oct. 5, 1918, pp. 192-103, 3 figs. Special feature is that nightsoil goes straight into small septic tank under seat, where it undergoes septic treatment.

Concrete Septic Tanks and Subsoil Disposal Fields for Country Homes, John H. Perry. Domestic Eng., vol. 85, no. 10, Dec. 7, 1918, pp. 363-365 and 391, 5 figs. Design and construction of such systems.

Sanitary Conveniences and Comforts for Country Homes. Clay-Worker, vol. 70, no. 6, Dec. 1918, pp. 501-503, 3 figs. Illustrates a manner in which ordinary sewer pipe and drain tile may be used.

Sewage-Pumping Station

Design and Operation of Automatic Sewage Pumping Station at West Haven, Conn., Clyde Potts. Mun. & County Eng., vol. 55, no. 6, Dec. 1918, pp. 199-200, 2 figs. Draining sewage to common point for treatment.

WATER SUPPLY

Freezing

How to Prevent Freezing of Riser Pipes to Elevated Water Supply Tanks. Mun. & County Eng., vol. 55, no. 6, Dec. 1918, pp. 213-214. Four means: (1) providing method for artificially heating water; (2) conserving heat in water by providing sufficient insulation; (3) maintaining temperature of water above freezing point by pumping and withdrawal of water; (4) adding chemicals to lower freezing point. From Water Tower.

Purification

Four Years' Operating Results of Minneapolis Water Purification Plant. Contract Rec., vol. 32, no. 47, Nov. 20, 1918, pp. 926-927. Filtration data of plant having capacity of 96,000,000 gal.

Algal Growths and Chlorine Treatment of London Waters, A. C. Houston. Contract Rec., vol. 32, no. 47, Nov. 20, 1918, pp. 929-930. Report of Director of Water Examination.

Water Treatment at Council Grove, Kansas, Louis L. Tribus. Can. Engr., vol. 35, no. 25, Dec. 19, 1918, pp. 536-538, 4 figs. Results obtained under highly varying conditions of turbidity at plant in operation for three years. Paper before Am. Waterworks Assn.

Reservoir Capacity

Determination of the Available Water Supply in the Haut-Cher Basin (Contribution à la détermination du régime hydraulique du Cher), P. Morin. Revue Générale de l'Electricité, vol. 4, no. 21, Nov. 23, 1918, pp. 805-806, 1 fig. Account of observations made to determine capacity of reservoirs which would insure continuous delivery.

Stream Pollution

Control of Stream Pollution, Earle B. Phelps. Can. Engr., vol. 35, no. 24, Dec. 12, 1918, pp. 515-518. Considers use of streams for waste disposal, effect of stream pollution, self-purification of streams, chemical methods of sewage treatment, biological treatment of sewage, and purification of water. From J. E. Aldred Lecture on Eng. Practice.

Relation of Main Drainage to River and Harbor Front Improvements in Various American Cities, Morris Knowles and John M. Rice. Mun. & County Eng., vol. 55, no. 6, Dec. 1918, pp. 204-205. Special reference to methods adopted for eliminating nuisance caused by discharge of raw sewage at Baltimore, New Bedford, Mass., Cleveland, Toronto, Syracuse, N. Y., Washington, Cincinnati, Waterbury, Conn., and Harrisburg, Pa.

WATERWAYS

Canal Traffic

The Potentialities of Our Inland Water Routes, Robert G. Skerrett. Rudder, vol. 34, no. 12, Dec. 1918, pp. 565-570, 11 figs. Economic and commercial aspects of developing possible canal traffic.

Flumes

Lindsay-Strathmore Irrigation Flume, Stephen E. Kieffer. Can. Engr., vol. 35, no. 25, Dec. 19, 1918, pp. 525-527, 5 figs. Self-supporting, high-level flume with 2-in. walls built on inside forms at rate of 130 lin. ft. per 8-hr. day; nearly $1,500,000 expended in improvements to 15,500 acres in Cal.

Groynes

Groynes as Applied to Water Control and Silt Exclusion. Indian Eng., vol. 64, nos. 14, 15 and 16, Oct. 5, 12 and 19, 1918, pp. 194-195, 206-208 and 222-223, 16 figs. Experiments with silt bags from the results of which writer concludes that when a canal is added to a Bell Bund system, flow behind groyne is introduced, but head still exists in pockets so that arrangement retains power of checking and diverting silt.

Navigable Rivers

The Study of Currents in Navigable Rivers (L'étude des courants dans les revières navigables), P. Dupont. Génie Civil, vol. 73, no. 17, Oct. 26, 1918, pp. 327-329. Recommends study of currents by engineers in order not to differ so often with mariners in regard to construction of improvements.

Calculations in Regard to Improvement of Rivers (Calculs concernant les améliorations de rivières), Alf. Bijls. Génie Civil, vol. 73, no. 19, Nov. 19, 1918, pp. 371-373, 1 fig. Concludes from examination and comparison of formulæ generally used, that in calculations it is advisable to deduce the coefficient of velocity from observations on long sections of 10 to 20 km. and to gage water at all possible levels.

Sediment in Rivers

Sediment in River Waters, J. S. Ryan. Tran. Inst. Marine Engrs., vol. 30, no. 238, Oct. 1918, pp. 217-218, 2 figs. Experience with propeller and shaft due to working amid water mingled with sand.

St. John River

St. John River Affords Big Opportunities, Frank S. Small. Can. Engr., vol. 35, no. 23, Dec. 5, 1918, pp. 489-495, 3 figs. Topographical features; reclamation of waste land by drainage; utilization of water powers; site proposed for tideless harbor.

St. Lawrence River

Canada's Heritage in the St. Lawrence River, Arthur V. White. Can. Engr., vol. 35, no. 24, Dec. 12, 1918, pp. 507-510, 2 figs. Indicates power sites on river and refers to canalization of river as a unit. Address before Elec. Club of Toronto.

Canada's Heritage in the St. Lawrence River, Arthur V. White. Elec. World, vol. 72, no. 26, Dec. 28, 1918, pp. 1216-1217, 1 fig. Estimated low-water power aggregates 2,000,000 hp., of which greater part is wholly within territorial area of Dominion and capable of development. From address before Elec. Club of Toronto, Nov. 12, 1918.

Mining Engineering

COAL AND COKE

California

Tesla Coal Mine, J. W. Beckman. Jl. Elec., vol. 41, no. 12, Dec. 15, 1918, p. 559. Indicates possibilities of a lignite mine in California.

Colliery Output

South Staffordshire and Warwickshire Institute of Mining Engineers. Presidential address, William Charlton. Trans. Instn. Min. Engrs., vol. 56, part I, Nov. 1918, pp. 13-26. Considers question of output in collieries under two aspects: 1, immediate and pressing need for United Kingdom to produce utmost possible quantity of coal; 2, standpoint of output per unit of person employed, and its bearing on prosperity of coal industry, and those other industries whose ultimate economic position is affected by use and cost of fuel.

What One Coal Mine Has Done. Stone & Webster Jl., vol. 23, no. 5, Nov. 1918, pp. 354-356. Mine in question hoisted 32,514 tons in one week.

GEOLOGY

Lake Michigan District

Explanation of the Abandoned Beaches About the South End of Lake Michigan, G. Frederick Wright. Bul. Geol. Soc. Assn., vol. 29, no. 2, June 1918, pp. 235-244, 3 figs. Peat deposits; series of moraines; supposed changes of level; glacial and clay deposits underneath Chicago; provisional estimates of glacial time afforded in this area. Presented in abstract before the Soc.

MAJOR INDUSTRIAL MATERIALS

Tungsten

Chief Materials Needed in the Electrical Industry: Tungsten (De quelques matières premières nécessaires à l'industrie électrique; le tungstene), D. Pector. Revue Générale de l'Electricité, vol. 4, no. 4, July 27, 1918, pp. 121-125. Metallurgy, uses and ore deposits. Bibliography of documents.

Zinc Concentration

Concentration of Lead-Zinc-Silver Ore at the Zinc Corporation's Mine, George C. Klug. Min. Mag., vol. 19, no. 5, Nov. 1918, pp. 243-245, 1 fig. Methods employed at Broken Hill. Gravity concentration by jigging and tabling for production of high-grade lead concentrate; treatment of zincy tailing by flotation methods (De Bavay, and Delprat); Seale-Shellshear method of cascading as modified by Lyster and Hebbard for selectively separating galena from mill pulp.

Zinc Tailings

Treatment of Accumulated Tailing as Practised by the Zinc Corporation, George C. Klug. Min. Mag., vol. 19, no. 6, Dec. 1918, pp. 298-300, 1 fig. Plant recovering zinc, silver and lead by mineral-separation process of removal in collective float and subsequent separation of a lead concentrate from collective float by tabling methods.

MINES AND MINING

Field Tests

Field Tests for the Common Metals in Minerals, George R. Fansett. Univ. of Ariz. Bul., bul. 93, Min. Technology Series no. 21, Nov. 1918, 20 pp. Compiled for Ariz. State Bur. of Mines and intended as text for lectures on Prospector's Mineralogy.

Fire Protection

Smothering Mine Fires (Note sur l'embouage des feux de mine), M. Cabane. Bulletin et compter rendus mensuelels de la Société de l'Industrie Minérale, series 5, vol. 14, 3d issue 1918, pp. 67-77, 6 figs. Principal features of system developed at Commentry Collieries; arrangement at Decazeville mines designed to deliver dust under pressure; materials used to form dust.

Safety

Miners' Safety and Health Almanac for 1919, R. C. Williams. Department of Interior, Bur. of Mines, Miners' Circular 24; 48 pp., 7 figs. Responsibility of miners concerning their own safety and that of others; pure drinking water for mining camps; prevention of accidents and promotion of sanitation; miners' anemia; disposal of human excreta in rural districts; sewage disposal in mines; mine-rescue cars of Bureau of Mines. Other articles dealing with health conditions and tending to impart information to miners are included in bulletin.

Sampling

Sampling, F. W. Bunyan. Min. & Sci. Press, vol. 117, no. 25, Dec. 21, 1918, pp. 827-832, 2 figs. Emphasizes importance of sampling in analytical work and illustrates with examples value of systematic procedure in performing it.

Stoping Methods

Mining Methods of United Verde Extension Mining Co., Charles A. Mitke. Bul. Am. Inst. Min. Engrs., no. 145, Jan. 1919, pp. 9-22, 3 figs. Considerations which influenced selection and planning of adaptable stoping method. Ore deposit considered as replacement of volcanic schist. Mineralization believed to have taken place after intrusions of diorite and quartz porphyry had folded and faulted schist.

Ventilation

Cooling and Drying the Air in Deep Mines, Sydney F. Walker. Iron & Coal Trades Rev., vol. 47, no. 2645, Nov. 8, 1918, p. 518. Writer believes coal may be mined successfully at depths from 5000 to 6000 ft. by treating each individual mine, each pair of shafts and the workings connecting them, in same manner as modern cold stores are treated. Gives recommendations and refers to actual installations.

Welfare Work

Welfare Work in the Mining Work in the Mining Industry, H. Lipson Hancock. Chem. Eng. & Min. Rev., vol. 10, no. 121, Oct. 5, 1918, pp. 6-13, 18 figs. Betterment work being done by South Australian company.

MINOR INDUSTRIAL MATERIALS

Arsenic

Arsenic and Its Occurrences in South Queensland (1), H. I. Jensen. Queensland Government Min. Jl., vol. 19, no. 221, Oct. 15, 1918, pp. 455-458. Notes on arsenic as a

source of trouble in metal extraction and on its origin and extraction.

OIL AND GAS

Gas Pressure

Record of Gas-Pressure from a Borehole, Charles J. Fairbrother. Trans. Instn. Min. Engrs., vol. 56, part 1, Nov. 1918, pp. 6-8, 2 figs. and (discussion) pp. 8-10. Photographs showing gas blowing out of borehole while clear of rods, and borehole with rods in and water being blown in all directions by force of gas.

Gas Storage

Natural-Gas Storage, L. S. Panyity. Bul. Am. Min. Engrs., no. 145, Jan. 1919, pp. 23-25, 2 figs. Scheme to regulate pressure by connecting exhausted well to high-pressure gas line.

Petroleum Hydrology

Petroleum Hydrology Applied to Mid-Continent Field, Roy O. Neal. Bul. Am. Inst. Min. Engrs., no. 145, Jan. 1919, pp. 1-8. Method of distinguishing between waters that encroach upon oil-bearing beds from sources in stratum and waters that reach oil sands from planes above.

PRECIOUS MINERALS

Gold

Two Instances of Mobility of Gold in Solid State, Edward Keller. Bul. Am. Inst. Min. Engrs., no. 145, Jan. 1919, pp. 33-42, 1 fig. Assay results of gold movement on surface of auriferous copper when latter is subjected to oxidation.

RARE MINERALS

New Minerals

Review of New Mineral Species (Revue des espèces minérales nouvelles), P. Gaubert. Bulletin de la Société Française de Minéralogie, vol. 41, no. 4-5-6, Apr.-June 1918, pp. 93-96 and 117-130. General notes on appearance, occurrence and constitution of 29 minerals discovered in recent years. Reference made in each case to publication where first account of substance appeared.

See also INDUSTRIAL TECHNOLOGY, Yttrium.

Metallurgy

BLAST FURNACES

Development in 1918

1918 Blast Furnace Development Reviewed, F. H. Wilcox. Blast Furnace, vol. 7, no. 1, Jan. 1919, pp. 30-31. Analysis indicates tendency has been toward large hearths, steep and low boshes, high inwall batters and moderate thickness of lining.

Gases

Remarks on the Composition of Blast-Furnace Gases and Volumetric Methods of Measuring the Gas Produced and the Air Blown In (Remarques relatives à la composition des gaz de haut fourneau et méthodes volumetriques pour le calcul du gaz produit et du vent soufflé), J. Seigle. Bulletin et Comptes rendus mensuels de la Société de l'Industrie Minérale, series 5, vol. 14, 3d issue 1918, pp. 113-131, 1 fig. Methods of measuring gases by weight (Gruner and Ledebur); volumetric methods based on combination of carbon or on combination of oxygen; examples of applications; comparison of theoretical results and practical analyses.

Manganese

How to Save Manganese and Coke. Iron Trade Rev., vol. 63, no. 24, Dec. 12, 1918, pp. 1347-1348. Table of operating data of 12 blast furnaces producing ferromanganese and spiegeleisen and 40 per cent of output of manganese alloys in U. S. Conclusion reached that large savings can be effected by using low-ash cokes.

Research

Study of Blast Furnaces, Based on the Researches Undertaken by Francis Mulet (Etude sur les hauts fourneux daprès les travaux de Francis Mulet), E. Damour. Bulletin et Comptes rendus meusuels de la Société de l'Industrie Minérale, series 5, vol. 14, 3d issue 1918, pp. 5-47, 1 fig. Economical operation of furnaces; analysis of charge and of gaseous products; heat required by chemical reactions; influence of temperature of blast on coke economy; utilization of gases; variation in coke consumption with output.

See also MECHANICAL ENGINEERING, Fuels and Firing (Blast-Furnace Gas).

COPPER

Brass, Cartridge

A Comparison of Grain-Size Measurements and Brinell Hardness of Cartridge Brass, W. H. Bassett and C. H. Davis. Bul. Am. Inst. Min. Engrs., no. 145, Jan. 1919, pp. 57-78, 16 figs. It was found that grain sizes of brasses annealed at low temperatures are greatly affected by previous grain size and reduction by rolling, consequently hardness of cartridge brass may be better determined by Brinell-hardness measurement than from grain size.

Bronzes

The Constitution of the Tin Bronzes, Samuel L. Hoyt. Bul. Am. Inst. Min. Engrs., no. 144, Dec. 1918, pp. 1721-1727, 15 figs. Explains upper heat effect over $\alpha + \beta$ range.

Chloridizing Roasting

Chloridizing-Roasting of Burnt Pyrites on the Ramen-Beskow System, Peter Klason. Min. Mag., vol. 19, no. 6, Dec. 1918, pp. 301-313, 4 figs. Suggests improvement of Longmaid-Henderson process for extracting copper from pyrites that have been burnt by alkali manufacturers.

Copper-Aluminum Alloys

Constitution and Hardness of Copper-Aluminum Alloys Having High Percentage of Copper (Constitution et dureté des alliages cuivre-aluminium riches en cuivre). La Metallurgie, year 50, no. 45, Nov. 6, 1918, pp. 1631-1633, 1 fig. Effect of temperature of hardening on hardness of alloys containing 9 to 16 per cent aluminum. (Continuation of serial.)

Leaching

The Utah Copper Enterprise (VIII). The Leaching Plant, T. A. Rickard. Min. & Sci. Press, vol. 117, no. 24, Dec. 14, 1918, pp. 787-791, 5 figs. Oxidized cap stripped from main mass of sulphide ore, averaging 0.65 per cent Cu in form of carbonates and 0.1 to 0.2 per cent additional in form of chalcopyrite and chalcolite, is dissolved with H_2SO_4 derived from decomposition of sulphide mineral. Plant has capacity of 2000 tons of ore per day. (To be continued.)

FLOTATION

Ruth Flotation Machine

Ruth Flotation Machine, Arthur J. Hoskin. Queensland Government Min. Jl., vol. 19, no. 222, Nov. 15, 1918, pp. 500-501, 3 figs. Machine for concentrating minerals by oil flotation; designed on principle that best attachment of minerals to bubbles takes place when there is least amount of relative motion.

STEEL AND IRON

Basic Steel

Formula for Strength of Basic Steel, Andrew McWilliam. Iron Age, vol. 102, no. 25, Dec. 19, 1918, pp. 1508-1511, 3 figs. Calculations made from composition; influencing principal elements; application to basic steel. Paper before Iron & Steel Inst., London, Sept. 1918.

Cast Iron

The Mixing and Melting of Cast Iron, J. F. Mullan. Can. Foundryman, vol. 9, no. 12, Dec. 1918, p. 304. Review of opinions expressed by several experts leads writer to assert that success of foundry depends more on proper management of furnace than on any other branch of the trade.

Electric Steel

Making Electric Steel for Roller Bearings, Edward K. Hammond. Machy., vol. 25, no. 4, Dec. 1918, pp. 318-326, 20 figs. Methods of operating Héroult electric furnaces, forging ingots, rolling billets and cold-drawing steel into solid bars and seamless tubing.

Ferro-Alloys

The Ferro-Alloys, J. W. Richards. Gen. Elec. Rev., vol. 21, no. 11, Nov. 1918, pp. 751-755. Composition of these alloys, method of manufacture, and properties imparted to steel by addition of each of the molten metals. Also Metal Trades, vol. 9, no. 12, Dec. 1918, pp. 488-489, 2 figs. Properties of ferromolybdenum, ferro-vanadium, ferrotitanium and ferroboron. Paper read at Nat. Exposition of Chem. Indus.

The Manufacture of Ferro-Alloys, Robert M. Keeney. Automotive Eng., vol. 3, no. 10, Dec. 1918, pp. 464-468. Ores and furnaces used and methods followed to produce ferrochrome, ferromanganese, ferromolybdenum, ferrotungsten, ferrovanadium and ferrouranium; uses of these metals.

The Manufacture of Ferro-Alloys in the Electric Furnace, E. S. Bardell. Min. Jl., vol. 123, no. 4346, Dec. 7, 1918, p. 708. Comparative efficiency of large and small furnaces used in manufacture of ferromanganese. Discussion of Am. Inst. Min. Engrs. paper by Robert M. Keeney.

Record of an Old Ferro-Silicon Furnace, I. Peterman. Blast Furnace, vol. 6, no. 12, Dec. 1918, pp. 492-493. Historical account of plant built in 1792, now a part of Warner Iron Co.

Forged Steel

Influence of Forging and Rolling on the Properties of Steel (Le corroyage de l'acier. Son influence sur les propriétés du metal), Georges Charpy. Revue de Métallurgie, year 15, no. 5, Sept.-Oct. 1918, pp. 427-448, 9 figs. Experiments conducted by engineering staff of large works; records of deformations by forging of straight lines drawn originally on surface of bar and examination of section of hollow threaded cylinder filled with liquid metal of same composition and rolled after solidifying under pressure of 1200 tons from 530 mm. in diameter to 265 mm.

Metallurgy in 1918

Phases of Iron and Steel Metallurgy in 1918, John Howe Hall. Iron Age, vol. 103, no. 1, Jan. 2, 1919, pp. 27-28. Remedies for ingot defects; strides in steel-casting industry; manganese problem; alloy-steel helmets.

Open-Hearth Furnaces

Principles of Open-Hearth Furnace Design, Chas. H. F. Bagley. Blast Furnace, vol. 6, no. 12, Dec. 1918, pp. 505-507, 3 figs. Calculations relating to pressure in furnace, port ends, ratio of air to gas passages. Flue and valve diagrams. Paper before British Iron & Steel Inst. (Concluded.)

Plate and Structural Mills at Fairfield, Ala. Iron Age, vol. 103, no. 1, Jan. 2, 1919, pp. 47-49, 3 figs. New plant of Tennessee Coal, Iron & Railroad Co., to serve Mobile shipyard; producing steel by triplexing at Ensley open-hearth works.

Oxygen in Steel

Determination of Oxygen in Steel. Iron Age, vol. 102, no. 26, Dec. 26, 1918, pp. 1573, 2 figs. Objections to Ledebur method apparently overcome; details of modifications; interesting comparative analyses.

The Heterogeneity of Steel (L'hétérogénéité de l'acier), H. le Chatelier and B. Bogitch. Génie Civil, vol. 73, no. 18, Nov. 2, 1918, pp. 350-351, 6 figs. Concludes, from experiments with Stead's reagent, that microscopic heterogeneity of steel is due to oxygen in solid solution in metal.

Russian Iron Works

Pre-War Russian Iron and Steel Plants. Iron Age, vol. 102, no. 25, Dec. 19, 1918, pp. 1501-1507, 11 figs. Output and equipment of leading works; prospects after war.

Structure of Steel

Inspecting the Structure of Metals, J. J. McIntyre. Am. Drop Forger, vol. 4, no. 11, Nov. 1918, pp. 443-444, 2 figs. Shows manner of taking structural photographs of metals or similar opaque objects with ordinary camera.

Development of Grain Boundaries in Heat-Treated Alloy Steels, R. S. Archer. Bul. Am. Inst. Min. Engrs., no. 145, Jan. 1919, pp. 51-55, 12 figs. Specimen is etched in 4 per cent solution of picric acid in ethyl alcohol from 5 to 25 min., then carbonaceous smudge is rubbed off on moist broadcloth or kersey.

See also MECHANICAL ENGINEERING, Heat Treating (Malleable Iron); Machinery, Metal-Working (Steel, High-Speed); ELECTRICAL ENGINEERING, Furnaces (Steel Furnaces).

Aeronautics

AEROSTATICS

Ascending and Landing

Military Aerostatics, H. K. Black. Aerial Age, vol. 8, no. 16, Dec. 30, 1918, p. 811. Precaution in ascending and in landing. (Continuation of serial.)

Balloons

Manufacture of War Balloons in U. S., Allen Sinsheimer. Automotive Indus., vol. 39, no. 22, Nov. 28, 1918, pp. 925-927, 6 figs. Adaptation of French Caquot type

Free Ballooning

Military Aerostatics, H. K. Black. Aerial Age, vol. 8, no. 14, Dec. 16, 1918, p. 705, 1 fig. Training in free ballooning. (Continuation of serial.)

Kites

Meteorological Kites (Cerfs-volants météorologiques), L-P. Frantzen. Aérophile, year 26, nos. 19 and 20, Oct. 1-15, 1918, pp. 298-299, 3 figs. Particulars of German design of "Diamant" type.

AIRCRAFT PRODUCTION

Navy Plant

Our Navy Winged Destroyers, Austin C. Lescarboura. Sci. Am., vol. 119, no. 24, Dec. 14, 1918, pp. 480-481 and 486-487, 8 figs. Work done by Navy in establishing Government-owned aircraft plant for supplying giant seaplanes.

Rigging

From a Rigger's Note-Book. Flight, vol. 10, no. 47, Nov. 21, 1918, pp. 1313-1315, 8 figs. General procedure of rigging. Case of a B. E. 2c is taken up in detail.

U. S. Air Service

Report of the Director of Military Aeronautics. Aerial Age, vol. 8, no. 14, Dec. 16, 1918, pp. 720-722. Story of development of personnel, training and organizing phases of present Air Service.

APPLICATIONS

Aeroplane Business

The Future of the Airplane Business, C. F. Kettering. Jl. Soc. Automotive Engrs., vol. 3, no. 6, Dec. 1918, pp. 358-362 and pp. 362-363 (discussion), 2 figs. Present difficulties in civilian use of airplanes as built at present; types of military airplanes. Presidential address before Detroit Section of Society.

American View

Future of the Aircraft Industry, Harry Bowers Mingle, Aviation, vol. 5, no. 9, Dec. 1, 1918, pp. 560-562, 3 figs. Enumerates possible uses of airplane in scientific, civil and sporting fields.

British Civil Transport

Civil Aerial Transport. Flight, vol. 10, no. 48, Nov. 28, 1918, pp. 1350-1351. Outline of report of Civil Aerial Transport Committee regarding steps to be taken to develop aviation for civil and commercial purposes and utilizing trained personnel for that purpose. From London Times.

Control of Aircraft

The Two Futures for Flight, H. Massac Buist. Flight, vol. 10, nos. 48 and 49, Nov. 28 and Dec. 5, 1918, pp. 1352-1354 and 1370-1373. Argues against establishment of bureaucracy in connection with development of aviation alike for military, public and private purposes, and for absolutely free scope for development and application by individuals or companies.

Dutch View of Future

Flying Machines and Air Communication and Navigation in the Near Future (Vliegmachines, bestuurbare luchtschepen en het luchtverkeer in de naaste toekomst). Ph. Kapteyn. De Ingenieur, year 33, no. 43, Oct. 26, 1918, pp. 827-845, 41 figs.

Italian View of Commercial Aviation

Commercial Aviation, Gianni Caproni. Aeronautics, vol. 15, no. 264, Nov. 6, 1918, pp. 428-430, 3 figs. From Rivista dei Transporti Aerei.

AUXILIARY SERVICE

Trucks

Building Trucks for the Aviation Service, M. E. Hoag. Am. Mach., vol. 49, no. 23, Dec. 12, 1918, pp. 1089-1092, 13 figs. Description of construction and assembly of some special parts. (Second article.)

ENGINES

Austro-Daimler

The 200 H. P. Austro-Daimler Aero Engine. Flight, vol. 10, no. 46, Nov. 14, 1918, pp. 1288-1293, 7 figs. Ignition; carburetor and induction system; petrol tanks; air pump; water pump; water cooling system; calibration and endurance test report; metallurgical test report; general data; general analysis by weights. Issued by Technical Department, Aircraft Production, Ministry of Munitions. Also Automobile Engr., vol. 8, nos. 120 and 121, Nov. and Dec. 1918, pp. 316-319, 350-357, 28 figs.

Design

The Design of Airplane Engines, III, John Wallace. Automotive Engr., vol. 3, no. 10, Dec. 1918, pp. 458-460. Mean effective pressure; power; construction of a theoretical diagram; modifying diagram to include practical conditions of ignition; comparison of results. (Continuation of serial.)

Hispano-Suiza

The Hispano-Suiza Aircraft Engine, Donald McLeod Lay. Jl. Soc. Automotive Engrs., vol. 3, no. 6, Dec. 1918, pp. 367-372, 9 figs. Historical review of design and development; mechanical features; circulating water and gasoline systems; production problems.

Four Hispano-Suiza Models. Automotive Indus., vol. 39, no. 22, Nov. 28, 1918, pp. 914-915 and 946, 2 figs. Details of models A, I, E, and H, built in U. S.

The Hispano-Suiza Airplane Engine. Aviation, vol. 5, no. 9, Dec. 1, 1918, pp. 549-553, 4 figs. History of development and detailed description of latest type.

Liberty

Details of the Liberty Engine, J. Edward Schipper. Automotive Indus., vol. 38, no. 24, Dec. 12, 1918, pp. 991-995, 12 figs. Mechanical description illustrated with sectional drawings.

Electrical System of the Liberty Engine, J. Edward Schipper. Automotive Indus., vol. 39, no. 26, Dec. 26, 1918, pp. 1089-1092, 14 figs. Special type of interrupter comprising three breakers in parallel. Storage battery designed to permit of upside-down flying.

The Liberty Motor, Douglas Wardrop. Aerial Age, vol. 8, nos. 14 and 15, Dec. 16 and 23, 1918, pp. 706-717, 762-765, 39 figs. Dec. 16: Extensive description of machine and outline of its development. Dec. 23: Oiling system; electric ignition; voltage regulator; duplex Zenith carburetor.

Starter

The Liberty Starter. Aerial Age, vol. 8, no. 16, Dec. 30, 1918, p. 816, 3 figs. Elevation and sections of 4-cylinder radial 2-cycle air motor. As starter it has a 9 to 1 gear reduction on final drive to motor.

HISTORY

Official U. S. History

Official History of Aircraft Production. Automotive Indus., vol. 39, no. 23, Dec. 5, 1918, pp. 968-969 and 987-990. Objects, problems, production, and results of air program.

MATERIALS OF CONSTRUCTION

Spruce

Development of the Aircraft Spruce Industry, Lawrence K. Hodges, Automotive Indus., vol. 39, nos. 25 and 26, Dec. 19 and 26, 1918, pp. 1037-1040 and 1100-1101, 8 figs. Organization of Spruce Production Division. Figures of monthly cut; problem of by-products disposal.

See also MECHANICAL ENGINEERING, Corrosion (Aircraft Parts).

METEOROLOGY

Aerographic Records

Uniformity in Aerographic Records, Alexander McAdie. Sci. Am. Supp., vol. 87, no. 2244, Jan. 4, 1919, pp. 15-16. Discusses desirability of universal scientific units. Special reference is made to meteorological work.

MODELS

Ford-Motored Aeroplane

Elementary Aeronautics and Model Notes, John F. McMahon. Aerial Age, vol. 8, no. 14, Dec. 16, 1918, p. 727, 16 figs. Construction of a Ford-motored airplane.

Model Construction

Model Aeroplane Building as a Step to Aeronautic Engineering, Aerial Age, vol. 8, nos. 11, 12, 15 and 16, Nov. 25, Dec. 2, 23 and 30, 1918, pp. 581, 627, 781 and 826, 16 figs. Table of resistance and weight of spruce struts. Table of plates of different aspect ratios at angles from 5 to 60 deg. showing K_y, K_x and ratio of lift to drift at the different angles. Bracing fuselage. Construction of seat, gas tank and rudder bar.

PLANES

Berg

The Austrian Berg Single-Seater. Flight, vol. 10, no. 46, Nov. 14, 1918, pp. 1285-1287, 9 figs. Wing section; attachment of struts to fuselage and longerons; details of internal bracing; ailerons. (Concluded.)

Bombers

The Gotha Bomber, with Notes on Giant Aeroplanes. Flight, vol. 10, nos. 46, 47, 48 and 49, Nov. 14, 21, 28 and Dec. 5, 1918, pp. 1280-1282, 1318-1322, 1340-1347 and 1375-1378, 84 figs. Nov. 14: Principal dimensions; construction; struts; ailerons; propeller accommodation; enpennage; fuselage. Nov. 21: Undercarriage; engine mounting; engines; controls; petrol system; armament; bombs; wireless; instruments; fabric and dope. Nov. 28: Particulars of four-engined giant. Dec. 5: Principal items of interest in five-engined giant brought down by allied forces. Issued by Technical Department, Aircraft Production, Ministry of Munitions. Also Engineer, vol. 126, no. 3281, Nov. 15, 1918, pp. 419-421, 8 figs.; Aeronautics, vol. 15, no. 266, Nov. 20, 1918, pp. 473-486, 79 figs.

De Haviland 4

The De Haviland 4, with Liberty "12" Engine. Aerial Age, vol. 8, no. 17, Jan. 6, 1918, pp. 860-861, 5 figs. General dimensions and weights.

Design

The Probable Trend of Aeroplane Design, R. F. Mann. Sci. Am. Supp., vol. 87, no. 2244, Jan. 4, 1919, p. 11, 1 fig. Review of present stage in development and changes likely to be introduced by reason of applications of airplanes to various purposes. From Flight.

The Trend of German Aeroplane Design. Flight, vol. 10, no. 49, Dec. 5, 1918, pp. 1383-1385. Comparison with British machine of principal features of captured German aeroplanes. Also in Aeronautics, vol. 15, no. 268, Dec. 4, 1918, pp. 518-520.

Gallaudet

The Gallaudet D-4 Light Bomber Seaplane. Aerial Age, vol. 8, no. 16, Dec. 30, 1918, pp. 817 and 831, 3 figs. General specifications. Machine is a biplane and is fitted with one 400-hp. Liberty "Twelve" engine.

Hannoveraner

The German Airplane Hannoveraner, C. L. II. (Avion allemand Hannoveraner C. L. II). Aérophile, year 26, nos. 19 and 20, Oct. 1-15, 1918, pp. 289-296, 10 figs. Comprehensive dedescription of light biplane fitted with 200-hp. Opel motor.

Junker

The Junker Armored Biplane. Flight, vol. 10, no. 48, Nov. 28, 1918, pp. 1356-1357, 2 figs. Main characteristics of all-metal aeroplane.

L-W-F

The L-W-F Model G-2 Fighting Airplane, Glenn D. Mitchell. Aviation, vol. 5, no. 9, Dec. 1, 1918, pp. 554-558, 7 figs. General features and dimensions of an all-American design.

Martin

The Martin K-III Single Seater. Aerial Age, vol. 8, no. 15, Dec. 23, 1918, pp. 759-761, 7 figs. Particulars of biplane specially designed as altitude fighter and equipped with oxygen tanks and provision for electrically heating pilot's clothing.

N. C. 1, U. S. Navy

Our Giant Aircraft. Sci. Am., vol. 120, no. 1, Jan. 4, 1919, pp. 7 and 18. General design of N. C. 1 equipped with three 12-cylinder Liberty engines driving three four-bladed tractor screws; wing spread, 126 ft.

Rumpler

Rumpler Two-Seater Biplane. Automotive Indus., vol. 39, no. 23, Dec. 5, 1918, pp. 962-965, 14 figs. Technical description of model German reconnaissance machine. Issued by British Aircraft Department.

PROPELLERS

Metal

The Metal Airscrew, Vladimir Olhovsky. Aerial Age, vol. 8, no. 12, Dec. 2, 1918, pp. 622-623, 2 figs. Results of experiments on wooden and metal propellers; factors entering in design of hollow metal propeller.

Patterns

Propeller Patterns, Joseph A. Shelly. Machy., vol. 25, no. 5, Jan. 1919, pp. 434-438, 8 figs. Describes method of laying out propeller patterns, assembling different sections and working blades to required form. (Second article.)

Research

Experimental Research on Air Propellers, II, William F. Durand. Automotive Eng., vol. 3, no. 10, Dec. 1918, pp. 478-480, 2 figs. Results of work done by Nat. Advisory Committee for Aeronautics. Torque dynamometer; revolution counter; air-speed meter; tests and calibrations of apparatus; uniformity of velocity over cross-section of air stream; relation between depression within experiment room and air-stream velocity. (To be concluded.)

Marine Engineering

AUXILIARY EQUIPMENT

Barge

Standard Concrete Barge for Use on the New York State Barge Canal. Engineering, vol. 106, no. 2759, Nov. 15, 1918, pp. 554-556, 6 figs. Drawings showing details of construction.


Starrett
A Few of the Many Styles and Sizes of
Starrett Tools
MANUFACTURERS, toolmakers, machinists, inspectors and mechanics in all trades recognize the Starrett Tools as Standards for accuracy, an assurance that comes through the knowledge that tools bearing the "Starrett" name are guaranteed.
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TOOLS

Bark, Auxiliary

Auxiliary Bark—The France, George Douglas. Rudder, vol. 34, no. 12, Dec. 1918, pp. 590-592, 5 figs. Sail plan, deck arrangement and design features of five-masted bark, 418.8 ft. long, fitted with two Schneider heavy-oil engines.

Fishing Cruiser

An Outdoor Motored Cruiser—Complete Plans and Building Instructions, William Atkin. Motor Boat, vol. 15, no. 23, 6 figs. Model is adaptation of flat-bottomed work boats used by clammers of Lower New York Bay.

Life Boats

Two Lifeboats in Place of One. Rudder, vol. 34, no. 12, Dec. 1918, pp. 588-590, 7 figs. Design providing partial collapse of one so it can be stowed under the other.

Producer-Gas Power Lighter

Design and Construction of Producer Gas Power Lighter, Frederick S. Nock. Int. Mar. Eng., vol. 24, no. 1, Jan. 1919, pp. 36-37, 3 figs. Special central control for engine and hoisting apparatus; double rudder installation; compact engine-room planning.

Towboat

Plans and Specifications of New Wood Tow Boats. Int. Mar. Eng., vol. 23, no. 12, Dec. 1918, pp. 673-674, 2 figs. Built for hard service; compound engine of 750 hp.; Scotch boiler with three Morison furnaces.

SALVAGE

Salving of the SS. "———," Frank A. T. Wheeler. Tran. Inst. Marine Engrs., vol. 30, no. 238, Oct. 1918, pp. 218-220, 3 figs. Steps taken to prevent falling over of vessel struck by torpedo on her port side in No. 5 hole, holes being blown in her 'tween deck and starboard side; watertight bulkhead at after end of engine room leaked badly and eventually flooded engine room.

SHIPS

Boilers

Sediment in Marine Boilers, Its Bearing on Furnace Collapse, W. R. Austin. Trans. Inst. Marine Engrs., vol. 30, no. 238, Oct. 1918, pp. 189-196, 1 fig. and (discussion), pp. 196-209. Occasions where risk arises and suggestions to eliminate it: Backing strains from unequal expansion and their prevention by keeping uniform temperature in furnaces; dangers arising from circulation of sediment caused by rolling of ship; possibilities of creating critical situation while cleaning a fire at sea; means of avoiding accident while lying under banked fires.

Concrete Ship

What the Year Has Taught About the Concrete Ship. Eng. News-Rec., vol. 82, no. 1, Jan. 1, 1919, pp. 14-15. Much learned regarding design and construction; future depends on ability to build in cost competition with steel; structurally, ship is success.

Concrete Ships and Barges (Los buques i barcos menores de concreto). Boletin de la Sociedad de Fomento Fabril, year 35, no. 9, Sept. 1918, pp. 614-619. History of development of process from 1849 to present time.

Shear in Concrete Ships Critical Point in Design, A. C. Janni. Eng. News-Rec., vol. 81, no. 24, Dec. 12, 1918, pp. 1089-1091, 1 fig. According to accepted theory, usual thin shell monolithic with frame gives rise to dangerous conditions.

Design

V-Bottom or Round Bilge—Which? George F. Crouch. Motor Boat, vol. 15, no. 23, Dec. 10, 1918, pp. 30-34, 3 figs. Advantages of each shape; diagrams showing relations between length and speed, and giving approximate form to use for different speeds.

Best Fore-and-Aft Position of Parallel Middle Body in Single-Screw Cargo Ship, William McEntee. Int. Mar. Eng., vol. 24, no. 1, Jan. 1919, pp. 18-23, 8 figs. Effect of variation of position of parallel middle body on shaft horsepower, propulsion coefficient and propeller revolutions. Paper before Soc. of Naval Architects and Marine Eng., Philadelphia, Nov. 1918.

Electric Transmission

Electric Propulsion of Vessels (La propulsion électrique des navires), A. Foillard. Génie Civil, vol. 73, no. 17, Oct. 26, 1918, pp. 321-327, 13 figs. Machinery used and characteristic curves of motors in the vessels Wulsty Castle and Mjölner.

Lubrication

Uniform and Constant Forced-Feed Lubrication of the Steamchests, Cylinders and Other Parts of Steam Engines. Ry. Engr., vol. 39, no. 466, Nov. 1918, pp. 203-209, 8 figs. Describes "Intensifore" Gorton type developed from exhaustive experiments with various mechanical and hydrostatic lubricators by engineering staff of Great Central Ry.

Power Plant

Marine Power Units, J. G. Callan. Wis. Engr., vol. 23, no. 2, Nov. 1918, pp. 42-47. General characteristics of steam turbines and Diesel engines. Reasonableness of adoption of geared unit.

Standards

Adopt British Ship Steel Standards. Iron Trade Rev., vol. 63, no. 22, Nov. 28, 1918, pp. 1245-1246. Decisions of American steel manufacturers at conference in Philadelphia.

Standardization of Ship Steel. Steel & Metal Digest, vol. 8, no. 12, Dec. 1918, pp. 690-691. Recommendation of mills to Emergency Fleet Corporation.

Structural Steel Standardization Cargo Vessels, Henry R. Sutphen. Int. Mar. Eng., vol. 23, no. 12, Dec. 1918, pp. 695-698, 1 fig. How quantity production was met; use of structural steel expedient; layout of yard.

Submarines

The Surrender of the Submarines. Min. Jl., vol. 123, no. 4345, Nov. 30, 1918, pp. 688-691, 5 figs. General features of construction of the different types, their propulsive machinery and other engineering details.

See also MECHANICAL ENGINEERING, Internal-Combustion Engines (Winton Marine Engine).

YARDS

Concrete Vessels

Build Boats in Dry Docks at New Yards in Detroit. Eng. News-Rec., vol. 82, no. 1, Jan. 2, 1919, pp. 21-24, 9 figs. Concrete barges under construction on concrete floors inside dikes which will be flooded for launching; lighters carry construction machinery alongside dry docks.

Reinforced Concrete Shipbuilding in Dorsetshire. Engineer, vol. 126, no. 3281, Nov. 15, 1918, pp. 408-410, 10 figs. Drawings with description of some concrete ships.

Building a Government 3500-Ton Concrete Ship. Eng. News-Rec., vol. 81, no. 24, Dec. 12, 1918, pp. 1058-1065, 16 figs. Fougner yard has concrete ways; reinforcement tacked to outside forms and finish put on with cement gun; air hammers on forms compact concrete.

Control of Construction

Control of the Construction of a 5000-Ton Deadweight Fabricated Steel Ship, "Fabricator." Int. Mar. Eng., vol. 23, no. 12, and vol. 24, no. 1, Dec. 1918 and Jan. 1919, pp. 691-694 and pp. 29-30, 6 figs. Dec. 1918: Special schedule for ordering and installation of machinery and equipment; correlation between order and purchasing departments. (Fourth article.) Jan. 1919: Forms for following up movement and arrival of steel parts; railway shipments of plates and sheets traced. (Fifth article.)

Costs and Estimates

Shipbuilding Costs and Estimates, James M. Robertson. Int. Mar. Eng., vol. 23, no. 12, Dec. 1918, pp. 671-672. Careful reading of specifications necessary; system a requisite; list of items; how to deal with individual items. (Second article.)

Cranes

Pre-Assembly System and Efficient Erection Cranes Speed Up Shipbuilding at Ecorse. Eng. News-Rec., vol. 81, no. 24, Dec. 12, 1918, pp. 1076-1081, 8 figs. Pre-assembling extending rapidly in Lake Yards; reduces erection labor on hulls.

Design

Berth Construction and Side-Launching Practice in Great Lakes Shipyards. Eng. News-Rec., vol. 82, no. 1, Jan. 2, 1919, pp. 7-13, 25 figs. Berth structure simple; timber and concrete foundations for support of ships; concrete launching-way stringers at one yard; keel blocks and cradles variously arranged; trip shores to release ships.

Ship-Design and Quantity-Production Methods of Newark Bay Yard. Eng. News-Rec., vol. 81, no. 25, Dec. 19, 1918, pp. 1122-1125, 4 figs. Project for factory-style shipbuilding based on enlisting new labor supply and using commercial steel; methods dictated by delay in ship orders; bridge shops fabricate straight parts.

Equipment

Fabricating Shop and Berth Equipment at Sun Shipyard. Eng. News-Rec., vol. 82, no. 1, Jan. 1, 1919, pp. 57-61, 9 figs. Assembly bay of shop delivers finished material to shipbuilding cranes; multiple punches and roller tables; reinforced-concrete berths served by bridge cranes.

Fabricated Ship

Fabricated-Ship Construction in One Year's Experience. Eng. News-Rec., vol. 82, no. 1, Jan. 2, 1919, pp. 16-17. New system now tested by large-scale working has proved adaptable and free from inherent difficulties or elements of excess cost.

Ford Eagles

Building the Ford Submarine-Chaser "Eagle." Int. Mar. Eng., vol. 24, no. 1, Jan. 1919, pp. 23-27, 7 figs. Simplicity of hull construction; safety devices on unusual launching platform; routing aids production.

Ford Methods in Ship Manufacture, Fred E. Rogers. Ind. Management, vol. 57, no. 1, Jan. 1919, pp. 1-6, 12 figs. Description of boat with features of plan of manufacture. (First article.)

Building the Ford Submarine Chaser "Eagle." Int. Mar. Eng., vol. 23, no. 12, Dec. 1918, pp. 702-705, 4 figs. Straight-line design; two parts of system; hurried development of process.

Hog Island

Hog Island, the Greatest Shipyard in the World, W. H. Blood, Jr. Int. Mar. Eng., vol. 23, no. 12, Dec. 1918, pp. 678-690, 20 figs. Review of conditions that preceded planning of yard; adopting type and design of boat; troubles encountered and overcome. Before Soc. of Naval Architects and Marine Engrs., Philadelphia, Nov. 1918.

Illumination

A Method of Ship Way Illumination, F. D. Weber. Jl. Elec., vol. 41, no. 11, Dec. 1, 1918, p. 503. Outlines method followed by western company.

Laying Out

Laying Down and Taking Off, Charles Desmond. Rudder, vol. 34, no. 12, Dec. 1918, pp. 584-587, 5 figs. How to lay out shape of transom stern inclined aft with rounded after face and intended to be made of pieces of material bent to shape. (Continuation of serial.)

New Yards

Large Addition to Plant of the Tidewater Shipbuilders, Ltd., Cap de la Madeleine, P. Q. Contract Rec., vol. 32, no. 51, Dec. 18, 1918, pp. 1001-1004, 6 figs. Extensions necessitated to build four 5100-ton steel cargo boats.

Shipbuilding at the Pensacola Yards, John M. Sweeney. Int. Mar. Eng., vol. 24, no. 1, Jan. 1919, pp. 12-16, 8 figs. Well-constructed plant for 9000-ton fabricated steel ship; use of permanent scaffolding; powerful plate-bending machine.

Routing of Materials

Routing of Fabricated Ship Material at Bristol. Eng. News-Rec., vol. 82, no. 1, Jan. 2, 1919, pp. 25-30, 9 figs. Hull construction operated on basis of shop-to-storage-to-ship system requires accurate timing of material supply, shop work, and assembly; routing handled by production department.

Welding

The Steel Ship and Oxy-Acetylene Welding, J. F. Springer. Can. Machy., vol. 20, no. 25, Dec. 19, 1918, pp. 701-703. Observations on behavior of metal under welding flame and precautions to be taken. Writer believes tensile strength of material at and near weld is much less than that of the plates. Of the restorative measures available, he considers reheating method the most convenient and effective.

Welding Designs for Shipyard Use, E. G. Rigby. Marine Rev., vol. 49, no. 1, Jan. 1919, pp. 22-29, 22 figs. Practical examples of electric welding in deck, tank and bulkhead structures; how it is applied to armor plate.

Electric Welding in Ship Construction, H. Jasper Cox. Int. Mar. Eng., vol. 24, no. 1, Jan. 1919, pp. 42-46, 7 figs. Methods of welding and apparatus described; inspection and testing welds; speed and cost of welding; Lloyd's experiments. Paper before Soc. of Naval Architects and Mar. Eng., Philadelphia, Nov. 1918.

The Steel Ship and Oxy-Acetylene Welding, J. F. Springer. Int. Mar. Eng., vol. 23, no. 12, Dec. 1918, pp. 699-701. Autogenous welding decreases strength of steel; behavior under heat; restorative measures.

The First Electrically Welded Boat, John Liston. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 844-848, 10 figs. Process followed in welding 42-ft. boat of 11-ft. beam said to have been plying Lake Erie for two years when the 275-ton, English-built, rivetless welded barge was launched in June 1918.

Electric Welding for Shipbuilding. Elecn., vol. 81, no. 2114, Nov. 22, 1918, pp. 619-620. From address by W. S. Abell, Chief Ship Surveyor of Lloyd's Register, before North-East Coast Inst. of Engrs. and Shipbuilders, Tyneside, Nov. 1918.

U. S. Warship Kept on the Job by Oxy-Acetylene Torch. Jl. Acetylene Welding, vol. 20, no. 6, Dec. 1918, pp. 290 and 292. Repair of boiler with oxy-acetylene outfit.

Electric Welding for Shipbuilding, W. S. Abell. Nautical Gaz., vol. 94, no. 24, Dec. 14,

1918, pp. 346-347. Past progress; strength of joints; possibility of industry. Paper before British Northeast Coast Instn. Engrs. & Shipbuilders.

The Adequacy of Welding in Constructing Hulls of Ships, H. M. Hobart. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 840-845. Investigations of Welding Research Sub-Committee of Emergency Fleet Corporation in regard to relative merits of different systems and equipments.

Spot Welding and Some of Its Applications to Ship Construction, H. A. Winne. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 923-927, 6 figs. Advantages of spot welding over riveting with respect to strength, time, and labor; limitations of spot welder; application of spot welding to construction of ladders and gratings and to plugging of misplaced holes.

Electric Welding in Navy Yards, H. G. Knox. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 849-859, 20 figs. Work conducted in each type of shop in a navy yard; recommendations of welding equipment desirable in each shop; data on speed and cost of welding ship structures; comparative cost data of welding based on records from steam railroads.

The Electric Arc Used in Steamship Overhauling. Can. Machy., vol. 20, no. 24, Dec. 12, 1918, pp. 675-676, 2 figs. Examples of uses of Westinghouse arc welder in repairing marine boiler and furnace while under steam.

Arc Welding in Shipyard, W. L. Roberts. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 860-864, 13 figs. Simplication of anglesmith's work by use of arc welding in production of staples; probability of abandoning staples in favor of directly arc-welding parts; application of electric arc to construction of water, oil, and air tanks, stacks, condensers, and other similar appliances.

Wooden Vessels

Building Wooden Vessels on the Pacific. Int. Mar. Eng., vol. 24, no. 1, Jan. 1919, pp. 8-11, 8 figs. Record of accomplishment; Hough and Ferris types give way to 5000-ton vessels; wood vessels coming into their own again.

VARIA

Emergency Fleet Corporation

Organization of the U. S. Shipping Board Emergency Fleet Corporation, Charles Piez. Jl. Am. Soc. Mech. Engrs., vol. 41, no. 1, Jan. 1919, pp. 32-35, 2 figs. Relationship and functions of Board and construction and operation divisions of Fleet Corporation.

Naval Engineering in War

The Achievements of Naval Engineering in the War, William L. Cathcart. Jl. Am. Soc. Mech. Engrs., vol. 41, no. 1, Jan. 1919, pp. 18-25, 18 figs. Organizations and principal activities of Bureau of Steam Engineering; electric drive for battleships; repair of German merchant ships by oxy-acetylene welding. Presented at annual meeting of Society.

U. S. Shipbuilding in 1918

Shipbuilding in the United States in 1918. Int. Mar. Eng., vol. 24, no. 1, Jan. 1919, pp. 5-7. Three million tons of merchant ship completed in first eleven months; rate of production rapidly increasing.

Organization and Management

ACCOUNTING

Expense Distribution

Efficiency and Democracy, H. L. Gantt. Jl. Am. Soc. Mech. Engrs., vol. 41, no. 1, Jan. 1919, p. 43. Suggestions in regard to accounting systems. Stress is laid on erroneous process of charging work with expense of idle machines.

EDUCATION

Apprentices

The Training of Engineering Apprentices, T. H. Fenner. Can. Machy., vol. 20, no. 23, Dec. 5, 1918, pp. 641-643, 4 figs. Analyzes necessary standard of education and suggests course of training.

Canada

Labor, Apprenticeship and Technical Education. Can. Engr., vol. 35, no. 24, Dec. 12, 1918, p. 511. Report of committee to Ottawa Conference of Assn. of Can. Building and Construction Industries.

Crippled Workers

How to Deal with Crippled Workers, T. Norman Dean. Am. Mach., vol. 49, no. 25, Dec. 19, 1918, pp. 1115-1116. Suggestions from deductions from scientific experience to relieve 2,122,000 industrial cripples in United States.

Physical Reconstruction of Crippled Men, Constance Drexel. Blast Furnace, vol. 6, no. 12, Dec. 1918, pp. 508-509. Plan of U. S. Government for rehabilitation and vocational training: schools established giving courses in oxy-acetylene welding, etc.

Re-Educated Soldiers in the Machine Trade, Katherine Freeman. Can. Machy., vol. 20, no. 25, Dec. 1918, pp. 691-692, 2 figs. Instances in which vocational reëducation, together with artificial limbs, have made injured soldiers earn more than in pre-war days.

Industrial Surveys for Physical Readjustment, A. B. Segur. Indus. Management, vol. 57, no. 1, Jan. 1919, pp. 63-65, 2 figs. Method of investigating possibilities of employing disabled persons in industry, developed by Red Cross Institute for the Blind; results shown for few operations in a meat-packing house.

Engineers

The Engineer in Foreign Service, L. S. Rowe. Jl. Am. Soc. Mech. Engrs., vol. 41, no. 1, Jan. 1919, pp. 31-32. Plea to broaden training of engineer in order that he may acquire a greater breadth of view which will permit his adaptability to international service.

English Language

Educational in English Language Promotes Efficiency, Sarah Elkus. Nat. Efficiency Quarterly, vol. 1, no. 3, Nov. 1918, pp. 140-149. Coöperation of Board of Education in promoting English classes in factories; English as a safety-first method.

S. A. T. C.

Students' Army Training Corps, Alexander S. Langsdorf. Proc. St. Louis Ry Club, vol. 23, no. 7, Nov. 22, 1918, pp. 115-127 and (discussion) pp. 127-129. Educational plan as developed by War Department after series of experiments. Special reference made to features and arrangements of Government contracts with Washington University.

Intensive Training, C. R. Dooley. Jl. Am. Soc. Mech. Engrs., vol. 41, no. 1, Jan. 1919, pp. 37-38. Program set up by Committee on Education and Special Training. It consisted of (1) military training, (2) sorting and training according to ability, (3) trade fundamentals and combinations, and (4) development of originality and initiative.

Shipyards

Industrial Training in War Time, E. E. MacNary. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 871-875, 4 figs. Procedure followed and accomplishments performed by Emergency Fleet Corporation. Article deals with teaching of eighteen different trades.

Training 350,000 Men for the Shipyards, J. Will Parry. Eng. News-Rec., vol. 82, no. 1, Jan. 1, 1919, pp. 53-56, 1 fig. How Fleet Corporation met problem.

Training Workers in Shipyards, R. V. Rickford. Int. Mar. Eng., vol. 24, no. 1, Jan. 1919, pp. 38-42, 12 figs. Short cut over old apprentice system; work progresses from simple to difficult operations; rivet records show results.

Trade Journals

Technical Journal Best Aid to Education, S. Balmfirth. Can. Foundryman, vol. 9, no. 12, Dec. 1918, pp. 307-309. After analyzing advantages and disadvantages of various sources of technical education writer concludes that technical journals, by reason of their ready availability and simplicity of style, are best help for self-instruction. Also in Can. Machy., vol. 20, no. 23, Dec. 5, 1918, pp. 655 and 657.

Training Factory

Lens Grinding in a Training Factory, Erik Oberg. Machy., vol. 25, no. 4, Dec. 1918, pp. 330-332, 3 figs. Means for meeting war emergencies devised by U. S. Government.

Vocational Schools

Need for vocational Schools in Mining Communities, J. C. Wright. Bul. Am. Inst. Min. Engrs., no. 145, Jan. 1919, pp. 91-94. Kinds of vocational schools which may be organized under the terms of the Federal Vocational Education Act.

Welders

The Training of Electric Welders, H. A. Horner. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 876-881, 9 figs. Development of ingenuity and manipulating skill necessitated by welding operators said to be principal aim of course given by instructors of Emergency Fleet Corporation.

Women

Service for Women in the Gisholt Shop, J. V. Hunter. Am. Mach., vol. 50, no. 1, Jan. 2, 1919, pp. 6-10, 17 figs. Methods used in training women workers in a Wisconsin shop.

Preliminary Training for Women Workers, Fred H. Colvin. Am. Mach., vol. 49, no. 24, Dec. 12, 1918, pp. 1067-1070, 9 figs. Account of methods employed in school of Packard Motor Car Co.

Motor Company's Shop Training for Women, F. L. Prentiss. Iron Age, vol. 102, no. 24, Dec. 12, 1918, pp. 1453-1455, 1 fig. Intensive work at Lincoln plant done in threshold school; women employees are protected by enforcement of rigid rules.

Work Schools

New Developments in Industrial Organization. Modern Methods of Port Sunlight (Ill.), W. G. Cass. Cassier's Eng. Monthly, vol. 54, no. 5, Nov. 1918, pp. 248-256. Work schools at Port Sunlight works.

FACTORY MANAGEMENT

Employment Managers

Aids to Employment Managers and Interviewers on Shipyard Occupations with Description of Such Occupations. Special Bul. U. S. Shipping Board Emergency Fleet Corporation, 1918, 147 pp. List of fundamental trades and occupations with most commonly accepted names used as standard. Specifications describe occupation from shipyard standpoint.

Duties of the Employment Manager, Charles W. Moon. Machy., vol. 25, no. 5, Jan. 1919, pp. 443-447, 9 figs. Fundamental principles involved and methods used successfully by R. K. Le Blond Machine Tool Co.

Employment Managers Graduate at the University of California, A. T. Parsons. Metal Trades, vol. 9, no. 11, Nov. 1918, pp. 450-452. Historical account of development of industrial activity involved in occupation of employment managers.

Handbook on Employment Management in the Shipyard. Organizing the Employment Department—I. U. S. Shipping Board Emergency Fleet Corporation 1918, 17 pp. Methods and processes of handling employment problems, which have been found successful in some of largest shipyards and corporations in U. S.

The Employment Manager a New Factor in the Industrial Relationship, Edward D. Jones. Wis. Engr., vol. 23, no. 2, Nov. 1918, pp. 48-53. Considerations on necessity for and meaning of formanizing labor as developed in new profession. Also in Metal Trades, vol. 9, no. 12, Dec. 1918, pp. 500-501.

Employment Methods

Installing Employment Methods, William Alfred Sawyer. Indus. Management, vol. 57, no. 1, Jan. 1919, pp. 7-11, 16 figs. Record of first year's work of employment and health department of American Pulley Co.

Interviewing and Selecting, Mark M. Jones. Indus. Management, vol. 57, no. 1, Jan. 1919, pp. 66-67. From address before Am. Assn. of Public Employment Officers.

Environment

Influence of Environment on Production, Lewis J. Brew. Am. Drop Forger, vol. 4, no. 11, Nov. 1918, pp. 428-429. Suggestions in layout and details of forge plant.

Equipment

Equipment for Diversified Production, A. B. Shuart. Am. Drop Forger, vol. 4, no. 11, Nov. 1918, pp. 429-430. Features of forge-plant design contributing to eliminate manual labor to large extent.

Ford Shipbuilding Methods

Ford Methods in Ship Manufacture—I, Fred E. Rogers. Indus. Management, vol. 57, no. 1, Jan. 1919, pp. 1-6, 12 figs. Basic features that made possible the production of Eagle submarine chasers. (To be continued.)

Foundry

Organizing a Foundry to Obtain Top Production, Paul R. Ramp. Foundry, vol. 47, no. 317, Jan. 1919, pp. 8-13, 5 figs. Systematic method of following up work of foremen in each department essential. From paper before Am. Foundrymen's Assn., Milwaukee.

Inter-Departmental Communications

Shooting the Shop Orders to Their Targets, Robert I. Clegg. Iron Age, vol. 103, no. 1, Jan. 2, 1919, pp. 53-55, 4 figs. Simple scheme of Geometric Tool Co. to rush instructions to departments the instant they are required.

Localization of Industry

The Localization of Industry, Malcolm Keir. Sci. Monthly, vol. 8, no. 1, Jan. 1919, pp. 32-48. Localization traceable as response to resources either in raw materials and power, or in unskilled labor; chance and monopoly as contributing factors; requirements of factories utilizing waste products; dependence of localized industries on skilled labor; influence of localization in formation of labor unions; deterrent features of localization.

Material Handling

Saving Tool Materials in Winchester Shop, W. E. Freeland. Iron Age, vol. 102, no. 26, Dec. 26, 1918, pp. 1574-1575, 2 figs. Work of central material planning division. Files are kept on steel basis. Tenth article dealing with methods at Winchester plant.

Organization

What Should Organization Achieve? Harry Tipper. Automotive Indus., vol. 40, no. 1, Jan. 2, 1919, pp. 17-18. Its effect on (1) providing incentive to work, (2) settling individual grievances and general disagreements, (3) improving the working force, (4) decreasing labor turnover, and (5) reducing friction between departments.

Production Control

Graphic Production Control—V The Control of Equipment and Labor, C. E. Knoeppel, Indus. Management, vol. 57, no. 1, Jan. 1919, pp. 56-62, 22 figs. Features of control said to improve efficiency of workmen, do away with idleness of equipment and improve faulty shop practice. (To be concluded.)

Public-Utility Plants

Practical Measures for Securing Greatest Economy in Public Utility Plant Operation, Charles Brossman. Mun. & County Eng., vol. 55, no. 6, Dec. 1918, pp. 206-208. Proper use of recording and indicating instruments; bonus system; examples of plant neglect.

Purchasing

Principles of Purchasing and Storing, Dwight T. Farnham. Indus. Management, vol. 57, no. 1, Jan. 1919, pp. 33-38, 6 figs. Instructions concerning storing of materials and supplies, their withdrawal from stock, preparing purchasing requisitions, obtaining bids and quotations, placing purchase orders, following up delayed purchase materials, and reporting receipt of materials. From U. S. Employment Service Bulletin.

Rates and Rate Setting

Time Studies for Rate Setting on Gisholt Boring Mills (III), Dwight V. Merrick. Cassier's Eng. Monthly, vol. 54, no. 5, Nov. 1918, pp. 271-275, 4 figs. Time required in actual manipulation of machine for cuts.

Establishing Basic Rates Saves Time Study Work, Carle M. Bigelow. Indus. Management, vol. 57, no. 1, Jan. 1919, pp. 17-22, 5 figs. Using as examples the determination of basic rate for a machine and finding basic rate for manual labor, writer points out how their use gradually increases usefulness of time-study men by simplifying vexatious problems of determining allowed times and repeated studies due to variation of product for single operation.

Shop Efficiency

The Cultivation of Shop Efficiency, H. J. MacMillan. Am. Drop Forger, vol. 4, no. 11, Nov. 1918, pp. 446-447, 9 figs. Contrasts present with past conditions in industrial relationship between employees. In illustration quotes work accomplished by Mueller Mfg. Co.

Tool System

A Simple Tool System, B. L. Van Schaick. Indus. Management, vol. 57, no. 1, Jan. 1919, p. 32, 1 fig. Plan based on actual inventory and formation of central crib where all grinding, dressing and repairing is done.

FINANCE AND COST

Cost Accounting

Cost Accounting to Aid Production—IV. The Principles of Burden Distribution, G. Charter Harrison. Indus. Management, vol. 57, no. 1, Jan. 1919, pp. 49-55, 2 figs. Details of method of obtaining machine rates, bringing in use of punched cards and sorting and tabulating machines. (To be continued.)

Cost Finding

True Cost Finding—What It Can Do for the Railroads, Morris Llewellyn Cooke. Indus. Management, vol. 57, no. 1, Jan. 1919, pp. 40-42. States that since main purpose in collecting cost data is to measure efficiency, its scientific application in railroad operation will provide gage for efficiency of each performance; and that initiative in scheming out an adequate cost finding system should be taken by U. S. Railroad Administration.

Cost Systems at Factories

Costing at National Factories, W. Webster Jenkinson. Iron & Coal Trades Rev., vol. 47, no. 2645, Nov. 8, 1918, pp. 513-516. Forms of progress records and cost returns; desirability of introducing cost system in a business. (Concluded.)

Cost Systems, Construction

How to Figure Construction Costs, Stanley D. Moore. Cement & Eng. News, vol. 30, no. 12, Dec. 1918, pp. 30-32. Notes on calculation of sewer system costs. Address at annual meeting of Iowa Eng. Soc.

INSPECTION

Fuel Supervision

Supervision and Fuel Economy, Robert Collett. Official Proc. N. Y. R. R. Club, vol. 29, no. 1, Dec. 1918, pp. 5452-5455. Recommends supervision by friendly counsel and encouragement.

LABOR

Bonuses

Day Labor, Force Account Work and Bonuses, Charles M. Upham. Good Roads, vol. 16, no. 25, Dec. 21, 1918, pp. 239-241. Discusses advantages and disadvantages. Paper presented at meeting of Am. Assn. State Highway Officials, Chicago.

Piece Work and Bonus System (Le travail aux pièces et la prime), M. Crémieux. Génie Civil, vol. 73, no. 17. Oct. 26, 1918, pp. 329-333, 8 figs. Established fundamental equations for comparison of these two systems of remunerating workers.

Compensation

Workmen's Compensation, Health Insurance and Hospitals, Thomas Howell. Modern Hospital, vol. 11, no. 5, Nov. 1918, pp. 414-416. Discussion of future relations of charitable hospitals to industry, indicating probable vast changes.

Cripples

An Experimental Employment Bureau for Cripples, Eleanor Adler. Modern Hospital, vol. 11, no. 5, Nov. 1918, pp. 402-405. Brief historical account of efforts to find employment for disabled with reference to establishment of bureau under control of Federation of Assns. for Cripples and the Hudson Guild.

Opportunities for Crippled Soldiers in the Metal Industries, Elsie Plant. Metal Trades, vol. 9, no. 11, Nov. 1918, pp. 448-449, 3 figs. Some of the things disabled men can do, as found by Red Cross Inst. for Crippled and Disabled Men.

Demobilization

When Labor Comes to Market, Walton H. Hamilton. Survey, vol. 41, no. 14, Jan. 4, 1919, pp. 425-428. Explanation and comment on demobilization chart of U. S. Labor Policies Board showing importance of rate at which demobilization is to be effected, analysis of problem and contingencies upon which solution depends.

Status of the Unproductive Worker, Harry Tipper. Automotive Indus., vol. 39, no. 25, Dec. 1918, pp. 1045-1046. Right of salaried workers to representation in organization with skilled and unskilled employees.

Employment Department

Employment Department, Hog Island Shipyard. Am. Mach., vol. 49, no. 23, Dec. 12, 1918, pp. 1071-1075, 11 figs. Shows forms used and describes process of employing men.

A Definition of "Penny-Wise, Pound Foolish," Applied to the Picking and Developing of Men for Big Jobs, Christian Girl. Monthly Jl. Utah Soc. Engrs., vol. 4, no. 9, Sept. 1918, pp. 169-175. Analysis of characteristics in personnel which contribute to stability of organization. Experience of writer in picking out men. From System.

Selecting Employees. Gas Industry, vol. 18, no. 12, Dec. 1918, pp. 359-362. Forms used by company covering appearance, mentality, and ability of applicants, who are examined on each by different person.

Housing

Instances of Industrial Housing. Stone & Webster Jl., vol. 23, no. 6, Dec. 1918, pp. 408-413, 11 figs. General appearance and finish of industrial housing at Mills of Carnegie Steel Co., and Buckeye Coal Co. Developments include building of houses, grading of streets, installation of water and sewer lines, etc.

The New E. F. C. Hotel at Hog Island, W. H. Blood. Stone & Webster Jl., vol. 23, no. 5, Nov. 1918, pp. 344-346, 4 figs. Views; rules; conveniences available. Hotel accommodates 2176 men.

Industrial Courts

New Basis for Industrial Relations, Harry P. Kendall. Am. Contractor, vol. 39, no. 52, Dec. 28, 1918, p. 17. Discusses establishment of set of federal industrial courts as in Australia, and formation of boards set up by workmen and their employees with equal representation on each side to determine standards of wages, hours and conditions of employment. Address before Nat. Councillors of Chamber of Commerce of U. S.

Labor Representation

How Labor Representation Operates. Iron Trade Rev., vol. 63, no. 24, Dec. 12, 1918, pp. 1349-1351. Presents plan adopted by Youngstown Sheet & Tube Co., in which the company commits itself to whatever may be declared to be just and equitable.

Political Plan of Organization Satisfactory for Relatively Small Establishments, Harry Tipper. Automotive Indus., vol. 39, no. 26, Dec. 26, 1918, pp. 1083-1084 and 1088. Combined work of employees' representatives and supervisors' committee.

Real Labor Representation, Harry Tipper. Automotive Indus., vol. 39, no. 24, Dec. 12, 1918, pp. 1006-1007 and 1010, 1 fig. Analysis of Midvale Steel & Ordnance Co.'s plan. Organization constituted of legislative and judicial committees elected by employees in the various plants.

Labor Situation

What About Labor? Business Digest & Investment Weekly, vol. 22, no. 12, Dec. 17, 1918, pp. 421-423 and 429. Reasons why, despite resumption of normal business activity, there is hesitancy due to possibilities in labor situation.

Mine Labor

Employment of Mine Labor, Herbert M. Wilson. Bul. Am. Inst. Min. Engrs., no. 145, Jan. 1919, pp. 83-85. Important aspects of securing and retaining workmen; purpose of Federal Board for Vocational Education.

Piece-Rate Card System

Layout and Piece-Rate Card System, John J. Borkenhagen. Machy., vol. 25, no. 4, Dec. 1918, pp. 327-329, 13 figs. Forms that assist in efficiency shop management.

Relations Between Employees

A Unique Method of Handling Employees. Jl. Elec., vol. 41, no. 10, Nov. 15, 1918, pp. 443-444. Promoting activities which will foster social relationship between them.

The Human Touch in Supervision, E. C. Clarke. Elec. Ry. Jl., vol. 52, no. 24, Dec. 14, 1918, 1048-1050, 3 figs. Object of management should be to instill spirit of coöperation among employees; how it may be done.

Wages

The Relation of Wages to Public Health, B. S. Warren and Edgar Sydenstricker. Am. Jl. Public Health, vol. 8, no. 12, Dec. 1918, pp. 883-887. Points out the necessity of providing families with suitable money value commensurate with local necessities and capable of eliminating undesirable factors which may bring about unhealthy conditions. Based on statistics for period 1907-1912.

Standardization and Administration of Wages, H. P. Kendall and E. D. Howard. Jl. Am. Soc. Mech. Engrs., vol. 41, no. 1, Jan. 1919, pp. 35-37. Consequences of system of contractual relations between employers and employees; work of the War Labor Policies Board; post-war labor problems; advisability of establishing system of organized labor participation in management.

Welfare

Welfare or Manpower Engineering? Frances A. Kellor. Nat. Efficiency Quarterly, vol. 1, no. 3, Nov. 1918, pp. 123-139. Contends that welfare work does not touch basic structure of plant management and that industrial relationship must be built in terms of engineering—impersonal, accurate, just and coördinated.

Women

Wartime Experience With Women Metal Workers. Foundry, vol. 47, no. 317, Jan. 1919, pp. 6-7. Their efficiency has been demonstrated in core shops, foundries and metal-working plants generally and in some respects they have been found superior to men.

Women Workers and Labor Turnover, Ida May Wilson. Indus. Management, vol. 57, no. 1, Jan. 1919, pp. 67-68. Temperamental and psychological factors determining complacency and permanency of women employees.

Women in Industry. Travelers Standard, vol. 6, no. 12, Dec. 1918, pp. 237-256, 9 figs. Present and future need for women; their limitations; selecting and training them; supervision and discipline; special aspects of safety problem; hours of labor; sanitation and general welfare; reference to American and European practices.

Woman's Place in Scientific Industry. Cassier's Eng. Monthly, vol. 54, no. 5, Nov. 1918, pp. 263-264. Woman's labor after demobilization.

The Women in Our Industries. Jl. Elec., vol. 41, no. 11, Dec. 1, 1918, pp. 499-500. Record of situation in U. S. with special reference to conditions in the West.

Developing Latent Labor Forces, John E. Otterson. Nat. Efficiency Quarterly, vol. 1, no. 3, Nov. 1918, pp. 168-178. Women as laborers.

Let the Women Do the Work, D. C. Fessenden. Metal Trades, vol. 9, no. 11, Nov. 1918,

pp. 435-438, 4 figs. Experience of several western companies.

LEGAL

Boiler Making

Legal Decisions Affecting Boiler Makers, John Simpson. Boiler Maker, vol. 18, no. 12, Dec. 1918, pp. 339-340. Employer responsible for condition of tools; employers' liability in America and England; employee's risk when precaution is disregarded; decision covering steam-pipe fitting; liability under federal boiler inspection act.

Change of Appliances

Change of Appliances, Chesla C. Sherlock. Power, vol. 48, no. 25, Dec. 17, 1918, p. 887. Some legal decisions.

Engineering License Laws

Engineering License Laws. Can. Engr., vol. 35, no. 25, Dec. 19, 1918, pp. 530 and 535. Report of committee appointed by Am. Assn. Engrs. to gather information concerning state engineering license laws, either proposed or in operation, and to draw up a standard license law.

Labor Legislation

Coördination of Legislative and Operative Functions in Labor Essential to Success, Harry Tipper. Automotive Indus., vol. 39, no. 23, Dec. 5, 1918, pp. 958-959 and 986. Organization fundamentals and changes; experiments in organization and their advantages. (Second series.)

Power Plants

Some Recent Legal Decisions. Power, vol. 48, no. 27, Dec. 31, 1918, pp. 970,971. Brief reports of some cases involving power plants.

LIGHTING

Chicago Factories

Productive Intensities, Wm. A. Durgin. Trans. Illum. Eng. Soc., vol. 13, no. 8, Nov. 20, 1918, pp. 417-424, and (discussion), pp. 424-428, 6 figs. Illumination survey of Chicago factories having connected load of 100 kw. or more.

Electrical Manufacturing Plants

Improved Lighting of Electrical Manufacturing Plants, F. H. Bernhard. Elec. Rev., vol. 73, no. 24, Dec. 14, 1918, pp. 917-922, 7 figs. Last of series of twelve articles on electric lighting in industries.

Inspection

Light, Electricity and the Shop, C. E. Clewell. Am. Mach., vol. 49, no. 25, Dec. 19, 1918, pp. 1117-1122, 11 figs. Description of educational plan for state factory inspectors in New Jersey and Pennsylvania and some results accomplished in these states.

Machine Tools

The Lighting of Machine Tools, Cassier's Eng. Monthly, vol. 54, no. 5, Nov. 1918, pp. 276-279, 4 figs. Schemes for lighting punching machine, bench vises, turret lathe and drilling machine.

War Effects

Lighting Units for Commercial, Office and Home Illumination. Elec. Rec., vol. 24, no. 6, Dec. 1918, pp. 45-53, 37 figs. Discussion of present practice with illustrations of the various types; emphasis laid on effect of war.

Wartime Lighting Economies. Trans. Illum. Eng. Soc., vol. 13, no. 8, Nov. 20, 1918, pp. 387-400 and (discussion) pp. 400-410. Rules limiting use of artificial light to minimum necessary numbers of hours per day, and promoting efficient use of artificial light during those hours. Prepared by Committee on War Service of Illum. Eng. Soc.

See also MARINE ENGINEERING, Yards (Illumination).

PUBLIC REGULATION

Federal Control of Labor

Effect of Federal Control on Railway Labor, W. S. Carter. Ry. Age, vol. 65, no. 24, Dec. 13, 1918, pp. 1061-1064. Outline of efforts to create improved relations between employer and employee.

Water-Power Development

A Plan for Power Development, C. Edward Magnusson. Jl. Elec., vol. 41, no. 10, Nov. 15, 1918, pp. 549-460, 1 fig. Scheme permitting Government aid without doing away with private enterprise and its application to State of Washington.

RECONSTRUCTION

Automobile Industry

Some Probable Effects of the War on the Automobile Industry, A. A. Remington, Automobile Engr., vol. 8, no. 120, Nov. 1918, pp. 306-311, 2 figs. Presidential address before Instn. Automobile Engrs.

British Export Trade

Quantity or Quality, W. Slater, Cassier's Eng. Monthly, vol. 54, no. 5, Nov. 1918, pp. 284-286. Remarks on British export trade.

Canada

Reconstruction in Canada and the Social and Economic Forces Which Will Condition It, J. A. Stevenson. Survey, vol. 41, no. 14, Jan. 4, 1919, pp. 441-446. Problem of repatriation of troops as being worked out by committee of cabinet.

Canada Readjusting from War to Peace, Carroll E. Williams. Mfrs. Rec., vol. 75, no. 1, Jan. 2, 1919, pp. 159-160. Plans of industrial and agricultural work for returning soldiers.

Dumping

The Truth About German Steel Dumping, E. T. Good. Cassier's Eng. Monthly, vol. 54, no. 5, Nov. 1918, pp. 286-288. Warning against introduction into England of German products; former German policy.

Exports

World Markets for American Manufacturers, Lynn W. Meekins. Sci. Am., vol. 120, no. 1, Jan. 4, 1919, p. 12. Factors limiting market in France; how Germany obtained East Indian business; possibilities in Dutch East Indies.

Cultivating Japanese Automotive Field (V), Tom O. Jones. Automotive Indus., vol. 39, no. 25, Dec. 19, 1918, pp. 1059-1061. Opportunities for American tire makers; suggestions to American manufacturers.

Cultivating the Chinese Automotive Field, Tom O. Jones. Automotive Indus., vol. 39, no. 26, Dec. 26, 1918, pp. 1106-1107 and 1122, 5 figs. Condition of Chinese roads as a factor in automotive development; types of cars for China.

Latin-American Exports

Entering the Export Markets of Latin America. IV The Value of Insurance, Percy F. Martin. Cassier's Eng. Monthly, vol. 54, no. 5, Nov. 1918, pp. 280-283. Advisability of insuring shipments against loss or damage.

Post-War Trade

Obstacles to Post-War Trade, Richard Cooper. Soc. of Engrs. Jl. & Trans., vol. 9, no. 11, Nov. 1918, pp. 169-179 and (discussion) pp. 179-187. Sets forth problems of reorganization of industry to peace work. Possible profit from a system of high wages indicated from author's experience in engineering and chemical industry.

Readjustment Problems

Readjustment Problems Confronting America, Harry A. Wheeler. Gas Age, vol. 42, no. 12, Dec. 16, 1918, pp. 511-514. Presidential address before Chamber of Commerce of United States, Atlantic City. Also in Am. Fertilizer, vol. 49, no. 12, Dec. 7, 1918, pp. 38-39.

Reconstruction Problems, M. F. Chase. Bul. Am. Inst. Min. Engrs., no. 145, Jan. 1919, pp. IX-XI. Parallel between European and American reconstruction problems; cancellation of contracts for war materials.

Petroleum and Reconstruction Problems, Chester Naramore. Bul. Am. Inst. Min. Engrs., no. 145, Jan. 1919, pp. XIV-XVIII. Erroneousness of conception that petroleum demands will decrease after signing of peace. Present leading position of U. S. in industry and means to perpetuate it.

Reconstruction of American Business, Edwin L. Seabrook. Boiler Maker, vol. 18, no. 12, Dec. 1918, pp. 338 and 352. Advisability of Government control during transitional period; adjustment of wages and prices; special legislation.

Organizing the Nation for Peace, L. W. Alwyn-Schmidt. Indus. Management, vol. 57, no. 1, Jan. 1919, pp. 45-48. Survey of general plans of England, France and Germany for redistributing labor, repatriating army, invalid labor, reëstablishing artisans and industrial housing. Also points out difficulties to be faced by United States in meeting world-wide competition.

See also MECHANICAL ENGINEERING, Motor-Car Engineering (Exports).

SAFETY ENGINEERING

California State Commission

Accident Prevention, John R. Brownell. Proc. Pacific Ry. Club, vol. 2, no. 8, Nov. 1918, pp. 12-13. Work being done by commission which administers State Compensation Fund created by California legislature in Workmen's Compensation Insurance and Safety Act.

Causes of Industrial Accidents

Factors Concerned in the Causation of Industrial Accidents. Automotive Indus., vol. 39, no. 22, Nov. 28, 1918, pp. 916-918. Comparison of report of Health of Munition Workers Committee of British Ministry of Munitions with U. S. Labor Bureau statistics.

Reduction of Accident Hazard, R. L. Gould. Cassier's Eng. Monthly, vol. 54, no. 5, Nov. 1918, pp. 265-270, 1 fig. Discussion of questions confronting safety engineer in his endeavor to minimize risk of accident to limb and life in industrial plants and suggestions for promoting work.

Cranes

Safety First for Crane and Operator. Jl. Elec., vol. 41, no. 11, Dec. 1, 1918, pp. 524-525, 2 figs. Special protection panel for cranes having three polyphase motors. Panel provides two inverse time-element overload relays for each motor.

Diseases

Diseases and Infections, Chesla C. Sherlock. Am. Mach., vol. 50, no. 1, Jan. 2, 1919, pp. 18-30. Some legal interpretations of liability.

Dust Inhalation

Effects of Dust Inhalation, J. S. Haldane. Queensland Government Min. Jl., vol. 19, no. 222, Nov. 15, 1918, pp. 515-517. Analysis of dust and result of experiments on its reported destructive effects. Paper submitted to Chem. Metallurgical & Min. Soc. of South Africa and to Instn. Min. Engrs.

Eye Protection

Eye Protection in Iron Welding Operations, W. S. Andrews. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 961-966, 7 figs. Charts illustrating spectra of commercially available glasses and their combinations, for use in selecting best protection against radiations of welding arc.

Inflammable Materials

The Dangers of Explosion With Inflammable Liquids and Vapors, W. Payman. Sci. Am. Supp., vol. 87, no. 2244, Jan. 4, 1919, p. 7. Criteria for judging liability of a given liquid to produce dangerous conditions; precautions necessary in handling inflammable liquids. From Jl. Soc. Chem. Indus.

The Dangers of Explosion with Inflammable Liquids and Vapors, W. Payman. Jl. Soc. Chem. Indus., vol. 37, no. 21, Nov. 15, 1918, pp. 406R-408R. Limits of inflammability of commoner organic solvents as recorded by different observers.

Lighting Defects

The Relation Between Light Curtailment and Accidents, R. E. Simpson. Trans. Illum. Eng. Soc., vol. 13, no. 8, Nov. 20, 1918, pp. 429-435 and (discussion) pp. 435-438. Considerations based on statistical figures and present systems of factory illumination.

Metal Industries

Causes and Prevention of Accidents in the Metal Industries, L. W. Chaney and Hugh S. Hanna. Metal Trades, vol. 9, no. 12, Dec. 1918, pp. 498-499, 3 figs. From Bul. 234 of U. S. Department of Labor.

Quarries

Accident Prevention in Quarry Operation, William H. Baker. Cement & Eng. News, vol. 30, no. 12, Dec. 1918, pp. 27-28. Work of Committee on Safety and Welfare of Atlas Portland Cement Co. From address before Nat. Safety Council.

Shop Safety Organization

Shop Safety Organization. The Bulletin, N. Y. State Indus. Commission, vol. 4, no. 3, Dec. 1918, pp. 48-52 and 57. Plan worked out by Bureau of Statistics and Information of State Industrial Commission and discussed at session of Industrial Safety Congress.

Steel Industry

Hazards Reduced in Steel Industry. Iron Trade Rev., vol. 63, no. 24, Dec. 12, 1918, pp. 1341-1345, 5 figs. Review of safety work of iron and steel industry in the last few years. From Bul. 234 of U. S. Bureau of Labor Statistics.

See also MINING ENGINEERING, Mines and Mining (Fire Protection; Safety).

SALVAGE

Waste Reduction

Conservation of Materials in Our Plants, Francis G. Hall. Am. Drop Forger, vol. 4, no. 11, Nov. 1918, pp. 440-441. Reducing waste by careful handling. (Second of Series.)

Salvaging Miscellaneous Wastes, W. Rockwood Conover. Indus. Management, vol. 57, no. 1, Jan. 1919, pp. 12-16, 3 figs. Methods for salvaging rubber, leather, fiber, rope, string, muslin rags, cloth trimmings, burlap sacks, old belting, asbestos sheeting, mica, insulation papers, wire, waste paper, boxes,

barrels, cans, containers, emery cloth, cotton waste, brooms, brushes, oil and fuel gas.

See also MECHANICAL ENGINEERING, Foundries (Salvage Work).

TRANSPORTATION

Inland Waterways

Handling Freight on Inland Waterways, H. McL. Harding. Int. Mar. Eng., vol. 23, no. 12, Dec. 1918, pp. 667-670, 6 figs. Advantages of effective inland terminals; operating costs small; importance of mechanical methods.

Motor-Truck Transport

Cost and Charges of Motor Truck Service. Ry. Rev., vol. 63, no. 23, Dec. 7, 1918, pp. 805-810, 9 figs. Some motor truck cost figures.

Rural Motor Express, S. W. Fenn. Jl. Soc. Automotive Engrs., vol. 3, no. 6, Dec. 1918, pp. 383-384 and (discussion) pp. 384-388. Work accomplished in Iowa; moving crops by motor trucks in Idaho; organization of rural lines in Tennessee, Alabama and Georgia.

VARIA

City Manager

Progress, Prospects and Pitfalls of the New Profession of City Manager, O. E. Carr. Can. Engr., vol. 35, no. 24, Dec. 12, 1918, pp. 513-514 and 519. Abstracted from paper before Fifth Annual City Mgrs. Convention.

Industrial Technology

Alcohol

Industrial Alcohol. Times Eng. Supp., no. 529, Nov. 1918, p. 228. Possible sources of supply.

Ammonium Nitrate

Coke Makers Now Make Nitrate of Ammonia, Mark Meredith. Chem. Engr., vol. 26, no. 12, Nov. 1918, pp. 451-452. English research proves it is commercially possible to turn ammonia by-product of coke ovens into nitrate of ammonia.

Clays

The Nature of the Air Content of Pugged Clays, H. Spurrier. Jl. Am. Ceramic Soc., vol. 1, no. 8, Aug. 1918, pp. 584-585, 1 fig. Apparatus to secure gas occluded in clay and result of analysis of gases collected from pugged-clay samples.

Burning Clay Wares (XXXII), Ellis Lovejoy. Clay-Worker., vol. 70, no. 6, Dec. 1918, pp. 496-498, 12 figs. Principle and arrangement of single outside stack kilns.

Chemical Industry

The Synthetic Organic Chemical Industry, Francis H. Carr. Jl. Soc. Chem. Indus., vol. 37, no. 22, Nov. 30, 1918, pp. 425R-428R. Importance of chemistry to the life of a nation and achievements of British chemists during years of war. From chairman's address to Nottingham Section.

Recent Progress and Future Development of Chemical Industries in France (Les progrès récentes et l'avenir des industries chimiques en France), Paul Razous. Génie Civil, vol. 73, nos. 19, 20 and 21, Nov. 9, 19 and 23, 1918, pp. 368-371, 390-393 and 407-410. Nov. 19: Potassium and sodium bichromates; mineral colors and varnishes; electrochemical industries; oils, pastes; fermentation; sugars; Nov. 23: Tanning industry; resins distillation of tars; carbonization of wood; artificial coloring.

The Criteria in the Declaration of Chemical Independence in the United States, I. Newton Kugelmass. Science, vol. 48, no. 1251, Dec. 20, 1918, pp. 608-612. Address at meeting of Alabama Section, Am. Chem. Soc.

Coal Products

Utilization of Lignite. Water & Gas Rev., vol. 29, no. 6, Dec. 1918, pp. 13-14. Characteristics of gas, ammonia, oils and tar obtained as by-products from lignite.

Distillation Tar from Mond Gas Plant, A. Gatley Lyons. Chem. Eng. & Min. Rev., vol. 10, no. 121, Oct. 5, 1918, pp. 19-20, 1 fig. Description of installation at Sulphide Corporation Works, New South Wales. Paper before Aust. Inst. Min. Engrs.

The Manufacture of Retort Coal-Gas in the Central States Using Low-Sulphur Coal from Illinois, Indiana and Western Kentucky, W. A. Dunkley and W. W. Odell. State of Ill., Div. Geol. Survey, bul. 21, 24 pp., 3 figs. Present use of central district coals; problems in their use in coal-gas manufacture; results reported; economical advantage of using them.

Dust Precipitation

Removing Foundry Dust by Electric Precipitation, H. D. Egbert. Foundry, vol. 47, no. 317, Jan. 1919, pp. 43-45, 6 figs. Two sets of electrodes used in Cottrell process, dust being charged with static electricity and attracted to collecting electrodes.

Cleaning Blast Furnace Gases by Electrical Precipitation, N. H. Gellert. Mfrs. Rec., vol. 74, no. 24, Dec. 12, 1918, p. 58. Tests on furnace operating on spiegeleisen and having a rated capacity of 200 tons of pig iron per day.

Enamels

Antimony Oxide as an Opacifier in Cast-Iron Enamels, J. B. Shaw. Jl. Am. Ceramic Soc., vol. 1, no. 7, July 1918, pp. 502-511 and (discussion) pp. 511-513. Results of experimental efforts to outline satisfactory working formulæ having antimony oxide as chief opacifying agent.

Preparation and Application of Enamels for Cast Iron, Homer F. Staley. Jl. Am. Ceramic Soc., vol. 1, no. 8, Aug. 1918, pp. 534-555, 3 figs. Details and arrangement of machinery in storing, weighing and mixing raw materials, melting enamel, drying, grinding and screening; operations followed in enameling process; enameling-room equipment.

How High-Grade Enameling Is Done, E. C. Kreutzberg. Iron Trade Rev., vol. 63, no. 23, Dec. 5, 1918, pp. 1290-1291, 4 figs. Practice followed in a New York plant.

Filtration

Filtration in the Laboratory, Robt. T. Smith. Color Trade Jl., vol. 4, no. 1, Jan. 1919, pp. 21-24. Modern methods: natural suction and under hydraulic head. Suggestions in regard to selection of papers and adaptation of accessory apparatus.

Glass

The Effect of Certain Impurities in Causing Milkiness in Optical Glass, C. N. Fenner and J. B. Ferguson. Jl. Am. Ceramic Soc., vol. 1, no. 7, July 1918, pp. 468-476. Reasons for opalescence with which certain pots of glass were affected at Bausch and Lomb plant and how it was overcome.

Gypsum

Some Factors Influencing the Time of Set of Calcined Gypsum, F. F. Householder. Jl. Am. Ceramic Soc., vol. 1, no. 8, Aug. 1918, pp. 578-583, 5 figs. Tests to determine effect of varying consistency of mixtures, time and rate of stirring and temperature of water used in mixing.

Mantle Lamps

Influence of B.t.u. on Gas Mantle Efficiency, R. S. McBride, W. A. Dunkley, E. C. Crittenden and A. H. Taylor. Gas Age, vol. 42, no. 12, Dec. 16, 1918, pp. 519-521, 3 figs. Extract from technological paper 110 of U. S. Bureau of Standards upon tests made in 1916 and giving data upon operation of mantle lamps.

Photography

Dyes in Photography, A. Seyewetz. Sci. Am. Supp., vol. 87, no. 2244, Jan. 4, 1919, p. 6. Their use in orthochromatic work and for non-halation plates. Abstract of paper in Chemie et Industrie, published in the British Jl. of Photography.

Pickling

The Chemistry of Pickling Baths. Automotive Indus., vol. 39, no. 23, Dec. 5, 1918, pp. 960-961. Action of acid on metal below scale; effect of variations in strength of bath and in temperature; modifying action of bath by organic and inorganic materials.

Niter Cake Substitute for Pickling Steel, E. E. Corbett. Blast Furnace, vol. 6, no. 12, Dec. 1918, pp. 497-501. Investigation conducted by U. S. Bureau of Mines chiefly for purpose of conserving sulphuric acid.

Picric Acid

The Manufacture of Picric Acid, Alexander Murray. Color Trade Jl., vol. 4, no. 1, Jan. 1919, pp. 5-8, 2 figs. General features of nitrating pots; nitrating operation; description of large installation; crystallization of picric acid.

Silica Products

Study of Silica Products, A. Bigot. Iron & Coal Trades Rev., vol. 47, no. 2645, Nov. 8, 1918, pp. 521-522. Recommendations in regard to grinding rocks and burning products. Abstract of paper before Refractories Section of Ceramic Soc. of Swansea.

Sugar Industry

On the Manufacture of Polariscopes in the United States, C. A. Browne. Louisiana Planter, vol. 62, no. 1, Jan. 4, 1919, pp. 12-14. Reasons for and against proposed change in manufacture of saccharimeters and getting away from German sugar scale and starting anew upon international scale proposed by Sidersky and Pellet. Opinions from 14 leading American chemists quoted.

Ultra-Violet Light

Ultra Violet Light (XIX), Carleton Ellis and A. A. Wells. Chem. Engr., vol. 26, no. 12, Nov. 1918, pp. 463-464 and 473. Its application in chemical arts.

Vegetable Drying

The Desiccation of Vegetable Substances at Different Temperatures (Sur la dessiccation des substances végétables effectuée à differentes temperatures), G. Andre. Bulletin de la Société Chimique de France, vol. 23, no. 10, Oct. 1918, pp. 430-437. Results of experiments at temperatures above 100 deg. cent. in which the substances were subjected to dry air deprived of CO_2.

Yttrium

The Preparation and Properties of Yttrium Mixed Metal, J. F. G. Hicks. Jl. Am. Chem. Soc., vol. 40, no. 11, Nov. 1918, pp. 1619-1626, 1 fig. Preparation in powder form by decomposing anhydrous chlorides with sodium in vacuo and by electrolysis of these chlorides in fused condition; study of solution of yttrium earth metals in fused cryolite and of loss of yttrium chloride by volatilization.

Water Gas

Water-Gas Manufacture with Central District Bituminous Coals as Generator Fuel, W. W. Odell and W. A. Dunkley. State of Ill., Div. Geol. Survey, bul. 22, 24 pp., 3 figs. Data gathered by writers during inspection of 20 water-gas plants in Illinois and surrounding states, in which bituminous coal from central mining district of Illinois, Indiana and western Kentucky is being used as generator fuel.

Wood Waste

Some Uses of Wood Waste, Armin Elmendorf. Wis. Engr., vol. 23, no. 2, Nov. 1908, pp. 33-39, 2 figs. Methods for converting waste material into products valuable for use in industries.

See also ELECTRICAL ENGINEERING, Power Applications (Electrochemical Processes).

Railroad Engineering

ELECTRIC RAILWAYS

Argentina

Electric Traction on the Central Argentine Railway. Ry. Gaz., vol. 29, no. 20, Nov. 15, 1918, pp. 518-524, 8 figs. Rolling stock. (Continuation of serial.)

Regenerative Braking

Braking System Permitting Recovery of Energy in Vehicles Operated by Single-Phase Commutator Motors (Système de freinage avec récupération d'énergie pour véhicles actionnés par moteurs monophasés à collecteur), Behn-Eschenburg. Génie Civil, vol. 75, no. 18, Nov. 2, 1918, pp. 347-350, 5 figs. Theoretical aspect of question as suggested from new developments permitting recovery of braking energy at all speeds and with any charge.

Rolling Stock

The New Rolling Material of the Dutch Electric Railways Co. (Het nieuwe rollend materieel der E. S. M.), H. F. Adams. De Ingenieur, year 33, no. 46, Nov. 16, 1918, pp. 893-904, 13 figs. Description of new electric cars.

ELECTRIFICATION

California

Railway Electrification Recommended. Jl. Elec., vol. 41, no. 10, Nov. 15, 1918, pp. 465-466. Report of investigations made preliminary to recommending electrification of mountain divisions of Cal. railroads to Director General of Railroads.

Montreal Tunnel

Electrification of the Montreal Tunnel Zone, William G. Gordon. Proc. Am. Inst. Elec. Engrs., vol. 37, no. 12, Dec. 1918, pp. 1285-1296, 7 figs. Method of constructing tunnel 3.1 miles long; details of equipment of substation and dimensions of locomotives and motor cars; features of catenary system due to local conditions and prevailing extremely low temperatures. Also Elec. News, vol. 27, no. 23, Dec. 1, 1918, pp. 29-30.

LABOR

Women

Women in the Service of the Railways, Pauline Goldmark. Ry. Age, vol. 65, no. 23, Dec. 6, 1918, pp. 1016-1018. Address before Labor

Reconstruction Conference, Academy of Political Science, New York, Dec. 6, 1918.

LOCOMOTIVES

Boilers

Report of Inspection of Locomotive Boilers. Ry. Rev., vol. 63, no. 26, Dec. 28, 1918, pp. 907-909, 1 fig. Department of Locomotive Inspection shows favorable results notwithstanding handicap of war.

Design

Modern Locomotive Engine Design and Construction (XLIII). Ry. Engr., vol. 39, no. 467, Dec. 1918, pp. 222-227, 4 figs. Different types of superheaters for any desired working pressure; design calculations and formulæ.

Feedwater Heating

Locomotive Feed Water Heating, H. S. Vincent. Ry. Mech. Engr., vol. 92, no. 12, Dec. 1918, pp. 645-649, 8 figs. Discussion of exhaust-steam and waste-gas methods of preheating for locomotive boilers.

Fireboxes

Radiant Heat and Firebox Design, J. T. Anthony. Ry. Mech. Engr., vol. 92, no. 12, Dec. 1918, pp. 658-660, 3 figs. Combustion chambers increase furnace efficiency and radiation; long tubes are of little value. From paper before Central Railway Club, May, 1918.

Individual Types

4-6-0 Passenger Engine and Double Bogie Tender: London and South-Western Railway. Ry. Engr., vol. 39, no. 467, Dec. 1918, pp. 228-229 and insert, 3 figs. Working drawings of engine and tender built at Eastleigh. Supplement to illustrations and particulars given in Oct. issue, pp. 184-186.

2-10-2 Type Locomotive for the Rock Island Lines. Ry. Age, vol. 65, no. 23, Dec. 6, 1918, pp. 992-994, 5 figs. Description with drawings and principal data.

A. T. & S. F. 4-8-2 Type Locomotives. Ry. Mech. Engr., vol. 92, no. 12, Dec. 1918, pp. 649-652, 2 figs. Drawings, description and principal data.

Standard Locomotives

Standard 4-8-2 and Light 2-10-2 Locomotives. Ry. Age, vol. 65, no. 24, Dec. 13, 1918, pp. 1067-1073, 12 figs. Drawings, descriptions and principal data.

Stokers

Mechanical Stoking of Locomotives, W. S. Bartholomew. Southern & Southwestern Ry. Club, vol. 14, no. 11, Sept. 1918, pp. 10-70 and (discussion) pp. 71-76, 62 figs. General arrangement of various types of stokers and their application to large freight and passenger locomotives; development of duplex stoker; result obtained in different types of locomotives.

Superheaters

Locomotive Superheater Maintenance. Ry. Mech. Eng., vol. 92, no. 11, Nov. 1918, pp. 621-623, 5 figs. From Bulletin No. 4, Locomotive Superheater Company.

Superheater Locomotive Performance. Ry. Mech. Eng., vol. 92, no. 12, Dec. 1918, pp. 652-655, 1 fig. From committee report presented at 1918 convention of Traveling Engrs'. Assn.

Three-Cylinder Locomotives

Three-Cylinder Locomotives, H. Holcroft. Ry. News, vol. 110, no. 2862, Nov. 9, 1918, pp. 331-332. Outline of British practice and study of problems involved in operating three valves by means of two gears. Paper before Instn. Locomotive Engrs.

Tires

Falling Weight Test on Railway Tyres, J. H. G. Monypenny. Engineering, vol. 106, no. 2759, Nov. 15, 1918, pp. 545-547, 8 figs. General discussion of this method of testing; suggestions in regard to changes in method.

NEW CONSTRUCTION

Hetch-Hetchy Project

San Francisco's Venture in Railroad Construction, A. J. Cleary. Ry. Age, vol. 65, no. 24, Dec. 13, 1918, pp. 1047-1050, 8 figs. Account of completion of 68-mile line as facility for Hetch-Hetchy project.

OPERATION AND MANAGEMENT

British

British Railways Under War Conditions. Engineer, vol. 126, no. 3281, Nov. 15, 1918, pp. 410-412. Early events after outbreak of hostilities. (Ninth article.)

British Railway Engineering and Operation —Some Immediate Problems to Be Faced, John A. F. Aspinall. Ry. News, vol. 110, no. 2862, Nov. 9, 1918, pp. 326-330. Presidential address before Instn. Civil Engrs.

Foreman

Mission of Railway General Foreman, Robert Quayle. Ry. Jl., vol. 25, no. 1, Jan. 1919, pp. 28-29. Possible ways in which foremen can approach their men and develop in them loyalty to organization.

Full Conservation

Coöperation in Fuel Conservation, D. R. MacBrain. Official Proc. N. Y. R. R. Club, vol. 29, no. 1, Dec. 1918, pp. 5447-5452. Necessity to secure interest in fuel conservation of every one in a railroad operating organization; influence of general condition of locomotive on fuel economy; time and experience required by an engineer to become master of locomotive engineering; education of firemen.

The Responsibility of General Officers for Fuel Economy, R. J. Pearson. Official Proc. N. Y. R. R. Club, vol. 29, no. 1, Dec. 1918, pp. 5445-5447. Importance of establishing system of supervision which will enable officers to ascertain consumption of fuel.

Address of Mr. Eugene McAuliffe. Official Proc. N. Y. R. R. Club, vol. 29, no. 1, Dce. 1918, pp. 5437-5445. Railway fuel, and railway fuel conservation. Working details of Fuel Conservation Section.

Reclamation

Reclamation on Chicago, Milwaukee & St. Paul. Ry. Rev., vol. 63, no. 26, Dec. 28, 1918, pp. 903-905. Adapted from report of special committee (H. S. Sackett, chairman) investigating status of reclamation with view to formation of future policy.

Tonnage Rating

Train Resistance and Tonnage Rating. Ry. Jl., vol. 25, no. 1, Jan. 1919, pp. 29-31. Reports received by Committee of Master Mechanics' Convention from 25 roads, dealing with experience, tests conducted, regulations adopted and methods of supervision.

PERMANENT WAY AND BUILDINGS

Ballasting

Modern Track Needs Good Ballast, R. C. Cram. Elec. Ry. Jl., vol. 52, no. 25, Dec. 21, 1918, pp. 1080-1085, 14 figs. Why well-ballasted track is economical to maintain; types of construction; properties and materials necessary for ideal ballast; ballast and ballasting from standpoint of best engineering practice.

Concrete-Base Track

Concrete Base Track Gives Good Results on Northern Pacific Railway. Eng. News-Rec., vol. 81, no. 24, Dec. 12, 1918, pp. 1071-1074, 13 figs. New type of construction four years in actual service; concrete slabs built on gravel roadbed have wood supports for rails; no ballast used; maintenance work not continuous but intermittent.

Grade Crossings

The Proper Engineering Treatment of Necessary Railroad Grade Crossings, Rodman Wiley. Good Roads, vol. 16, no. 26, Dec. 21, 1918, pp. 241-243. Claims no engineering advice has dictated present policy of establishing crossings in railroads. Paper before Am. Assn. of State Highway Officials, Chicago.

Stresses in Track

Stresses in Permanent Way. Ry. Engr., vol. 39, nos. 464, 465 and 466, Sept., Oct. and Nov. 1918, pp. 179-181, 191-194 and 211-213, 13 figs. Report of joint committee of Am. Soc. Civil Engrs. and Am. Ry. Eng., Assn., appointed to investigate stresses in railway track.

Ties

A New Concrete Railroad Tie. Mun. & County Eng., vol. 55, no. 6, Dec. 1918, pp. 212-213, 3 figs. Details of tie satisfactorily used for several years on municipal railroad of San Francisco, Cal.

Service Tests of Cross-Tie, P. R. Hicks. Bul. Am. Ry. Eng. Assn., vol. 20, no. 210, Oct. 1918, pp. 21-71. Tables comprising 350 service test records on 28 different species of ties, including 30 completed records submitted by 22 railroads.

Resilient Chairs and Reinforced Concrete Ties for Railway Track. Contract Rec., vol. 32, no. 47, Nov. 20, 1918, pp. 921-922, 2 figs. Details of sleeper said to have given satisfactory service on East Indian Ry.

Track Improvement

Making the Old Track Last a Little Longer, P. Ney Wilson. Elec. Ry. Jl., vol. 52, no. 24, Dec. 14, 1918, pp. 1053-1054, 5 figs. What Connecticut Co. did to extend life of stretch of track in New Haven, with particular reference to arc welding.

See also CIVIL ENGINEERING, Bridges (Railway Bridges).

RAILS

Transverse Fissures

Transverse Fissures Cause Rail Failures, Ry. Age, vol. 65, no. 23, Dec. 6, 1918, pp. 1007-1009. Suggests that rails are being stressed beyond service limit. (From report by W. P. Borland, chief of Bureau of Safety of Interstate Commerce Commission of an investigation made by James E. Howard, engineer-physicist of Commission.) Also Ry. Rev., vol. 63, no. 24, Dec. 14, 1918, pp. 843-847, 11 figs.

Reheating as Cure for Rail Fissure, G. F. Comstock. Iron Trade Rev., vol. 63, no. 26, Dec. 26, 1918, pp. 1457-1462, 17 figs. Metallographic investigations of transverse fissures, using a special etching reagent; results apparently support theory that transverse failures are due to defect in steel and that reheating of blooms will diffuse bands of phosphorus. From paper to be presented at Feb. meeting of Am. Inst. Min. Engrs.

ROLLING STOCK

Cleaning

Rotary Brushes for Cleaning Cars, C. H. Shaffer. Ry. Jl., vol. 25, no. 1, Jan. 1919, pp. 26-27, 2 figs. Brush operated at about 900 r.p.m. through special flexible shaft used in conjunction with air drill.

Refrigerator Car, Standard

Government Standard Refrigerator Car. Ry. Rev., vol. 63, no. 25, Dec. 21, 1918, pp. 865-868, 5 figs. Data and further description of Government's new design. Detail drawings. Also Ry. Mech. Eng., vol. 92, no. 12, Dec. 1918, pp. 663-668, 6 figs. and Ry. Age, vol. 65, no. 25, Dec. 20, 1918, pp. 1115-1117.

Welded Freight Car

Electrically Welded Gondola Car. Ry. Rev., vol. 63, no. 24, Dec. 14, 1918, pp. 833-835, 5 figs. Car constructed for C., B. & Q. R. R. pioneer attempt at fabricating steel freight-car structure by process of electric welding. Also Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 913-915, 8 figs.

SAFETY AND SIGNALING SYSTEMS

Accident Prevention

The Conservation of Man-Power, H. A. Adams. Proc. Pacific Ry. Club, vol. 2, no. 8, Nov. 1918, pp. 7-11. Brief record of work done by Government, Congress and private agencies to prevent accidents in railroad operation, including present endeavors of U. S. Railroad Administration.

SHOPS

A. E. F. Repair Shops

Railroad Repair Shops in France Equipped and Operated by American Forces, Robert K. Tomlin, Jr. Eng. News-Rec., vol. 81, no. 26, Dec. 26, 1918, pp. 1178-1182, 6 figs. Features of shops; individual electric drive for all machine tools.

Roundhouse Design

Locomotive Round-House at San Bernardo, Chile (La maestranza de San Bernardo, Chile), C. V. Cruchaga. Boletin de la Sociedad de Fomento Fabril, year 35, no. 9, Sept. 1918, pp. 609-614. Details of American design built of concrete and is said to be largest of its kind in the world.

Roundhouse Methods

Mileage of Engines—Its Relation to Cost of Shop and Running Repairs, George H. Logan. Ry. Jl., vol. 25, no. 1, Jan. 1919, pp. 24-26. Remarks on shop practice based on experiences in roundhouses.

Accuracy in Locomotive Repairs, M. H. Williams. Ry. Mech. Eng., vol. 92, no. 12, Dec. 1918, pp. 673-677, 8 figs. Methods of making and of fitting new and repair parts for locomotives with gages and micrometers.

Tools, Brass-Working

Brass-Working Tools in a Railroad Shop, Frank A. Stanley. Am. Mach., vol. 49, no. 23, Dec. 12, 1918, pp. 1081-1084, 8 figs. Describes tools for making blow-off valves and their fittings.

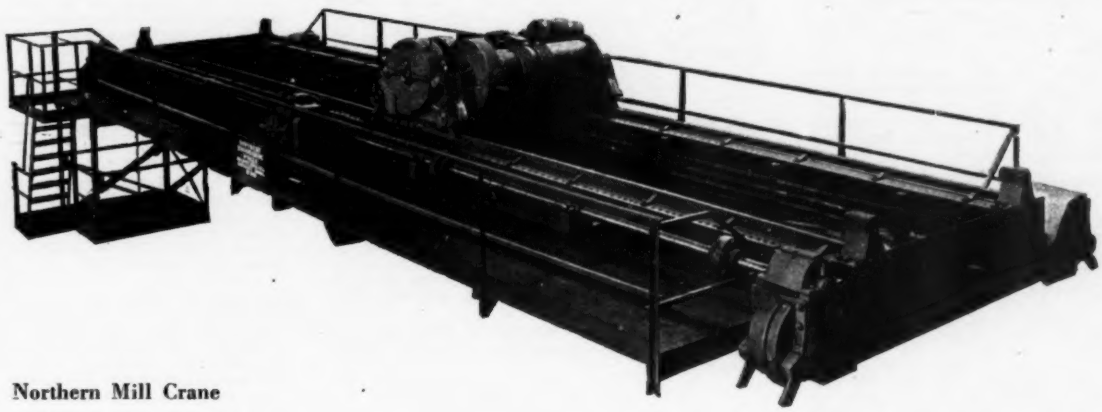
Welding

Arc Welding in Railroad Shops, B. C. Tracy. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 887-808, 20 figs. Based on its success in locomotive repair work, writer believes arc welding must be given serious consideration by railroads, not only from an economic viewpoint, but also to increase transportation facilities.

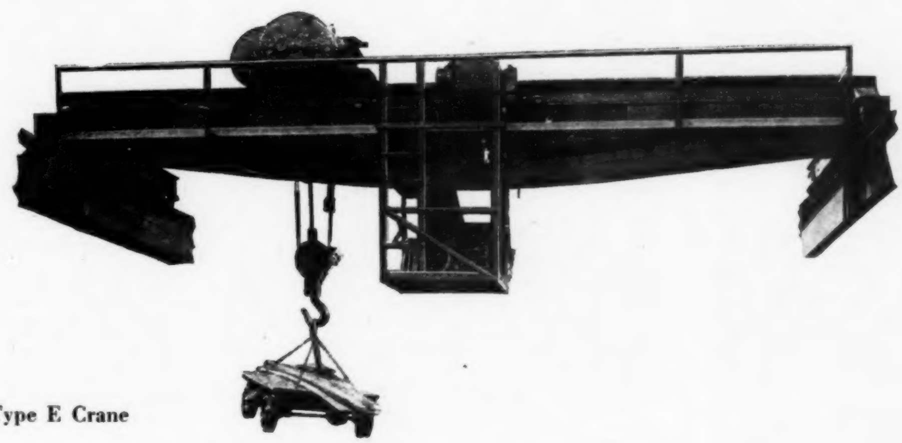
TERMINALS

South Boston

New Haven Improvements at South Boston Terminal. Ry. Age, vol. 65, no. 26, Dec. 27, 1918, pp. 1149-1152, 7 figs. Involve construction of two additional tracks and depressing old line. All done under heavy traffic.



Northern Mill Crane



Northern Type E Crane

Munitions and Military Engineering

Ambulance Trains

Ambulance Train of the American Army (Train-ambulance de l'armée américaine). Génie Civil, vol. 73, no. 18, Nov. 2, 1918, pp. 341-343, 15 figs. Disposition and arrangement of coaches (built in England) for transportation of wounded soldiers.

Automobile Transport

Organization of the French Army Automobile Service, W. F. Bradley. Automotive Indus., vol. 39, no. 26, Dec. 26, 1918, pp. 1093-1095. How repairs were handled. Equipment included 90,000 trucks and 150,000 men.

Military Transport Chassis. Part IX. Automobile Engr., vol. 8, no. 121, Dec. 1918, pp. 346-349, 4 figs. Their performance under war conditions. Details of Pierce-Arrow 5-ton model R, 8 truck.

Camp Holabird—Largest Truck Overhaul Depot. Automotive Indus., vol. 39, no. 25, Dec. 19, 1918, pp. 1053-1055, 8 figs. Data on plant with capacity for assembling 30 trucks a day and crating 22 an hour for shipment.

Construction Work

How Construction Met the Issue, R. C. Marshall. Am. Contractor, vol. 39, no. 51, Dec. 21, 1918, pp. 22-25. Accomplishments of construction Division of War Department. Functions, organizations and procedure; "cost-plus and sliding scale fee contract." Address at meeting of Gen. Contractors' Assn.

Gun Erosion

Experts Discuss Big Gun Erosion, Hudson Maxim. Iron Trade Rev., vol. 63, no. 26, Dec. 26, 1918, pp. 1463-1464. Analysis of causes producing erosion and study of possibilities to overcome them, together with recommendations in regard to material and method of lining. Discussion of Henry M. Howe's paper before Am. Inst. Min. Engrs.

Hand Grenades

Making the American Hand Grenade, Edward K. Hammond. Machy., vol. 25, no. 5, Jan. 1919, pp. 448-453, 15 figs. First of two articles on methods of machining and loading bodies and assembling bouchons.

H. E. Shells

Manufacture of High Explosive Shells and Detonators, from the Metallurgist's View Point, C. B. Swander. Proc. Steel Treating Research Soc., vol. 1, no. 11, pp. 9-14, 5 figs. Outline of forging operations on an 8-in. American carbon-steel high-explosive shell; machining; nosing operation; heat treating; copper banding; placing detonator; British, French and Russian detonators.

Howitzers

How the 155-Mm. Howitzer Is Made, J. V. Hunter. Am. Mach., vol. 49, no. 25, Dec. 19, 1918, pp. 1123-1129, 28 figs. Third article.

Illuminating Shells

Rockets and Illuminating Shells as Used in the Present War, A. Bergman. Illum. Engr., vol. 11, no. 8, Aug. 1918, pp. 189-191. Composition and data on candlepower developed. From paper before Illum. Eng. Soc.

Military Roads

Some Phases of Military Road Work, Gordon F. Daggett. Wis. Engr., vol. 23, no. 3, Dec. 1918, pp. 79-88. Trend of construction during last two years. Difficulties encountered, organizations required and materials available in work undertaken at the front. Requirements of wearing surface for military purposes.

Railway Artillery

Railway Artillery, James B. Dillard. Jl. Am. Soc. Mech. Engrs., vol. 41, no. 1, Jan. 1919, pp. 44-49, 5 figs. Development of models; types of cannon used; problems of design; barbette mortar carriages; foreign types; American types; auxiliary cars; tactical uses; value and economy of seacoast defence.

Long-Range Heavy Navy Guns with Railway Mount, D. C. Buell. Jl. Am. Soc. Mech. Engrs., vol. 41, no. 1, Jan. 1919, pp. 25-27, 5 figs. Work done in completing mobile battery of naval 14-in. 50-caliber guns originally built for use in battle cruisers.

The War Department Railway Artillery. Ry. Age, vol. 65, no. 25, Dec. 20, 1918, pp. 1113-1114, 5 figs. Brief description of 8-in., 12-in. and 14-in. railway mounts.

Semi-Steel Shells

How Semisteel Shell Are Machined. Iron Trade Rev., vol. 63, no. 22, Nov. 28, 1918, pp. 1236-1237, 17 figs. From circular of Ordnance Department recommending standard practice for manufacture of this class of projectile.

Tanks

The Mark VIII Land Cruiser, J. Edward Schipper. Automotive Indus., vol. 40, no. 1, Jan. 2, 1919, pp. 6-9, 11 figs. Technical description of large-sized battle tank developed during latter period of war; equipped with an adaptation of Liberty aircraft engine and weighs 40 tons. Also Motor Age, vol. 35, no. 1, Jan. 2, 1919, pp. 18-21, 9 figs. Mechanical features of huge model that carries 11 men.

Tools for Shell Manufacture

Special Tools and Appliances for Shell Manufacture, George A. Neubauer and Erik Oberg. Machy., vol. 25, no. 5, Jan. 1919, pp. 416-421, 7 figs. Describes number of devices used by Buffalo Pitts Co. in making 4.7 high-explosive shells. (First article.)

Tools for Boring a Closed-Bottom Shell, M. H. Potter. Machy., vol. 25, no. 5, Jan. 1919, pp. 427-428, 6 figs. Types of blades used in boring heads and methods of grinding and setting blades.

See also MECHANICAL ENGINEERING, Foundries (War Demands); Forging (Gun Forgings).

General Science

CHEMISTRY

Analysis

Quantitative Analysis of Metals by Electrolytic Deposit Without Using External Source of Electrical Energy (Sur un procédé de dosage des métaux par dépôt électrolytique sans emploi d'une énergie électrique étrangère), Maurice François. Comptes rendus des séances de l'Académie des Sciences, vol. 167, no. 20, Nov. 11, 1918, pp. 725-727. From a conductor resting on borders of platinum crucible containing sulphuric acid or similar reagent and salt to be analyzed a zinc or aluminum hook is suspended. Electrolytic action deposits metal in salt at bottom of crucible.

Method of Chromic Oxide Determination, W. C. Kiddell and Esther Kitredge. Chem. Engr., vol. 26, no. 12, Nov. 1918, pp. 457-458. Government chemists claim new method permits rapid handling of ore samples submitted for analysis. (To be concluded.)

The Quantitative Analysis of Small Quantities of Gases, H. M. Ryder. Jl. Am. Chem. Soc., vol. 40, no. 11, Nov. 1918, pp. 1656-1662, 3 figs. Description of apparatus for analyzing water vapor, CO_2, CO, O, H, N and methane; its manipulation; results of tests made to determine its accuracy.

Catalytic Exothermic Gas Reactions

Starting and Stability Phenomena of Ammonia Oxidation and Similar Reactions, F. G. Liljenroth. Gen. Elec. Rev., vol. 21, no. 11, Nov. 1918, pp. 807-815, 7 figs. Explains fundamental characteristics of catalytic exothermic gas reactions.

Methane

Methane, William Matisoff and Gustav Egloff. Jl. Phys. Chem., vol. 22, no. 8, Nov. 1918, pp. 529-575. Formulation of results of research up to date and their classification along physical (constants, specific properties, gas properties, industrial application) and chemical (combustion, explosion, solubility, occlusion, industrial reactions) characteristics; notes on possibilities of research on methane both theoretical and practical.

Occluded Gases in Glass

Gases and Vapors from Glass, R. G. Sherwood. Phys. Rev., vol. 12, no. 6, Dec. 1918, pp. 448-458, 8 figs. Author finds that under the influence of heat there are two distinct kinds of gaseous evolution products, namely, one associated with absorption—readily removable at 200 deg. cent., and other resulting from formation of new chemical equilibria. Also Jl. Am. Chem. Soc., vol. 40, no. 11, Nov. 1918, pp. 1645-1653, 9 figs.

Rare Earths

Observances on the Rare Earths (VIII). The Separation of Yttrium from Erbium; the Ratio $Er_2\ O_3$: 2 Er Cl_3, Edward Wichers, B. S. Hopkins and C. W. Balke. Jl. Am. Chem. Soc., vol. 40, no. 11, Nov. 1918, pp. 1615-1619. Comparison between cobalticyanide and nitrite precipitation methods; preparation of erbium material by nitrate fusion method; determination of ratio of erbium oxide to erbium chloride in seven analyses.

Structure of Matter

The Atomic Structure of Carborundum Determined by X-Rays, C. L. Burdick and E. A. Owen. Jl. Am. Chem. Soc., vol. 40, no. 12, Dec. 1918, pp. 1749-1759, 4 figs. Measurements of angles of reflection of palladium X-rays from principal planes of crystal of carborundum and interpretation of measurements of intensities of reflection of different orders. Writers conclude elementary tetrahedron of carborundum differs from that of diamond only in a slight shortening of vertical axis and slight difference in displacement of carbon atoms from centers of tetrahedron.

MATHEMATICS

Elliptic Functions

On the Coefficients in the Expansions of Certain Modular Functions, G. H. Hardy and S. Ramanujan. Proc. Roy. Soc., vol. 95, no. A667, Nov. 7, 1918, pp. 144-155, 2 figs. Three theorems relating to properties of elliptic functions in powers of variable $Q = e^n$, where $n = \pi i \tau$.

Equations

On the Characteristics of Partial Derivative Equations of Second Order (Sur les caractéristiques des équations aux dérivées particlles du second ordre), E. Gau. Comptes rendus des séances de l'Académie des Sciences, vol. 167, no. 19, Nov. 4, 1918, pp. 675-678. Invariant for characteristics of system by two quadratures.

Systems of Coördinates, G. H. Light. G. H. Light. Univ. of Colo. Jl. Eng., vol. 15, no. 1, Oct. 1918, pp. 23-27, 4 figs. Intrinsic equation of catenary and cycloid in system defined by length of arc and radius of curvature.

Heaviside Development Theory

Generalization of Heaviside Development Theorem (Généralisation du théorème du développement de Heaviside), Abraham Press. Revue Générale de l'Electricité, vol. 4, no. 19, Nov. 9, 1918, pp. 691-693. States that Carson (Phys. Rev., Sept. 1917, pp. 217-225) does not quite generalize theorem in question because the applied forces he considers have the exponential form; writer accordingly takes up case of any forced vibration by discussing general differential equation with constant coefficients.

Rectification of Arc

Notes on a Geometrical Construction for Rectifying Any Arc of a Circle, F. A. Lindemann. Lond., Edinburgh & Dublin Phil. Mag., vol. 36, no. 216, Dec. 1918, pp. 472-474, 1 fig. Process involving successive bisections and based on rapidly converging trigonometric series.

Single-Sided Surfaces

A Surface Having Only a Single Side, Carl Hering. Jl. Franklin Inst., vol. 186, no. 5, Nov. 1918, pp. 627-630, 4 figs. Further variations and minor corrections in study of surface generated by line moving along circle, always remaining in planes passing through axis of circle and simultaneously revolving around circle as axis at half angular rate of its movement along circle. Addendum to article in Aug. issue.

PHYSICS

Calorimeters

Calorimetric Lag, Walter P. White. Jl. Am. Chem. Soc., vol. 40, no. 12, Dec. 1918, pp. 1858-1872. Mathematical treatment of elimination of three lag effects of bodies external to calorimeters: (1) change in heat capacity of calorimeter, (2) thermal leakage, (3) loss dependent on jacket temperature.

The Conditions of Calorimetric Precision, Walter P. White. Jl. Am. Chem. Soc., vol. 40, no. 12, Dec. 1918, pp. 1872-1886. Expressing leakage effect as a function of time, thermal head for experimental period and leakage modulus of calorimeter, the effects of diminishing each of these on the values of other two are analyzed and rules for calorimetric precision are derived.

Crystals

Experimental Study on the Growth of Crystals (Etude expérimentale sur le développement des cristaux), René Marcelin. Annales de Physique, vol. 10. Sept.-Oct. 1918, pp. 185-188. Report of observations on paratoluidine. It appeared that these crystals grew not in depth but in surface by successive alluvions.

Formation and Optical Study of Sodium Chromate Crystals Having Four Water Molecules (Mode d'obtention et étude optique des cristaux de chromate de soude à 4 molécules d'eau), Lucien Delhaye. Bulletin de la Société Française de Minéralogie, vol. 41, nos. 4-5-6, Apr.-June 1918, pp. 80-93, 4 figs. Experimental research: Variation of three principal indices in terms of wave length; variation of apparent and true angles in turns of wave length; variation of position of bisectors in crystal in terms of wave length.

Crystalloluminescence

Crystalloluminescence (II), Harry B. Weiser. Jl. Phys. Chem., vol. 22, no. 8, Nov. 1918,

pp. 576-595, 1 fig. Survey of theories advanced by various investigators concerning nature of triboluminescence (property of many crystalline substances which emit phosphorescent light when rubbed or crushed); theory that it is the result of chemical action and is identical with crystalloluminescence so far as chemical reaction is concerned, differing only between themselves in physical process employed to bring about reaction; experiments with arsenic trioxide and with potassium sulphite.

Curie and Haüy Laws

Note on Curie and Haüy Laws (Sur les lois de Curie et de Haüy), C. Viola. Bulletin de la Société Française de Minéralogie, vol. 41, nos. 4-5-6, Apr.-June 1918, pp. 108-116. Demonstrates inter-connection of the two laws, Haüy's being developed analytically from Curie's differential fundamentals.

Curie Point in Iron

Curie's Point in Pure Iron and Ferrosilicon Alloys (Le point de Curie dans le fer pur et les ferro-siliciums), A. Sanfourche. Comptes rendus des séances de l'Académie des Sciences, vol. 167, no. 19, Nov. 4, 1918, pp. 683-685. Experimental measurements of termal manifestation at Curie's point. Alloys experimented on contained from 0.5 to 2.5 per cent silicon.

Density of Gases, Determination

An Accurate Method for Measuring the Density of Gases, O. Maas and J. Russell. Jl. Am. Chem. Soc., vol. 40, no. 12, Dec. 1918, pp. 1847-1852, 1 fig. Applicable to gases which can be condensed by liquid air or some other freezing agent. Known volume at known pressure and temperature is liquefied in bulb attached to containing vessel; bulb is then sealed off and gas weighed at room temperature.

Double-Suspension Mirror

The Double Suspension Mirror, L. Southerns. Lond., Edinburgh and Dublin Phil. Mag., vol. 36, no. 216, Dec. 1918, pp. 477-486, 8 figs. Theory of a method of observing deflections in a delicate balance; method a modification of "double suspension mirror."

Drops

Sounds Produced by Drops Falling on Water, A. Mallock. Proc. Roy. Soc., vol. 95, no. A667, Nov. 7, 1918, pp. 138-143, 6 figs. Theoretical determination of shape of cavity a falling sphere must make when it penetrates a fluid; experimental confirmation by instantaneous shadow photographs of falling shot.

Electromagnetic Vectors

The Electromagnetic Vectors, H. Bateman. Phys. Rev., vol. 12, no. 6, Dec. 1918, pp. 459-481. Geometrical study of an electromagnetic field in relation to a moving observer and location of vectors with aid of two cones which at each point limit directions of forces acting on electric and magnetic charges moving with velocities less than that of light; expression of electromagnetic laws in terms of forces on unit electric and magnetic charges in motion and deductions relating to lines of force, derived from Hargreaves' theorems for space-time integrals; discussion of energy in electromagnetic field; development of theory in regard to amount of concealed energy in field of moving electron.

Explosion, Effects of

On the Rupture of Mirrors and Window-Panes by Explosions (Sur la rupture des glaces et des vitres par les explosions), P. Gaubert. Bulletin de la Société Française de Minéralogie, vol. 41, nos. 4-5-6, Apr.-June 1918, pp. 65-67. Explanation for shapes commonly presented by pieces into which a large plate breaks as result of explosion.

Fluorescence

The Physical Characteristics of X-Ray Fluorescent Intensifying Screens, Millard B. Hodgson. Phys. Rev., vol. 12, no. 6, Dec. 1918, pp. 431-435, 2 figs. Fluorescence of various materials discussed from point of view of photographic efficiency; qualitative determination of spectral distribution of fluorescence from calcium tungstate; photographic efficiency of characteristic radiation from silver, tungsten, platinum and lead.

Fluorescence (La fluorescence), Jean Perrin. Annales de Physique, vol. 10, Sept.-Oct. 1918, pp. 133-159. Destruction of fluorescent bodies by emission of fluorescence; influence of temperature on intensity of emission; molecular and atomic fluorescence; limiting power; fluorescence of concentrated solution; fragility of fluorescent molecules.

Gravitation

On a Peculiarity of the Normal Component of the Attraction Due to Certain Surface Distributions, Ganesh Prasad. Lond., Edinburgh and Dublin Phil. Mag., vol. 36, no. 216, Dec. 1918, pp. 475-476. Cases in which component N of Newtonian attraction at point P along normal through P meeting surface at O tends to no limit as P approaches O along normal.

Impact

The Photographic Study of Impact at Minimal Velocities, C. V. Roman. Phys. Rev., vol. 12, no. 6, Dec. 1918, pp. 442-447, 6 figs. Graphs showing relation between coefficient of restitution and velocity of impact for polished spheres of equal radius of brass, aluminum, hard bronze, white marble, and lead.

Inflammability of Gaseous Mixtures

The Inflammation of Mixtures of Methane and Air in a Closed Vessel, Richard Vernon Wheeler. Jl. Chem. Soc., vols. 113 and 114, no. 673, Nov. 1919, pp. 840-859, 7 figs. Results of experiments in spherical vessels. Giving data on maximum pressures developed, rates of development of pressure, and speeds of propagation of flame.

Ionization

Ionization of Mercury, Sodium and Potassium Vapors and the Production of Low Voltage Arcs in These Vapors, T. C. Hebb. Phys. Rev., vol. 12, no. 6, Dec. 1918, pp. 482-490, 2 figs. Concludes from experiments that: Potassium vapor can be ionized at 1.6 volts; sodium vapor at 2.5 volts; D lines of sodium can be excited at less than 1.0 volt; sodium and potassium arcs in mercury vapor can operate below their resonance potentials and as low as 1.4 for sodium and 0.5 volts for potassium; mercury spectrum can be produced at 0.5 volt in atmosphere of mercury and potassium.

Latent Heat of Fusion

Latent Heat of Fusion as the Energy of Molecular Rotations, Kōtarō Honda. Phys. Rev., vol. 12, no. 6, Dec. 1918, pp. 425-430. Tables and calculations, based on Landolt and Börnstein's values, which lead writer to assert that latent heat of fusion consists of energy of rotation of molecules gained during fusion.

Light Emission

On the Light Emitted from a Random Distribution of Luminous Sources, Lord Rayleigh. Lond., Edinburgh & Dublin Phil. Mag., vol. 36, no. 216, Dec. 1918, pp. 429-449, 3 figs. Mathematical treatment of probable expectation of intensity in any direction. By "expectation" is meant the mean of a large number of independent trials, or combinations, in each of which the phases are redistributed at random. Sonorous vibrations are considered but the results are shown to be applicable to electric vibrations.

Light Polarization

The Light Scattered by Gases: Its Polarization and Intensity, R. J. Strutt. Proc. Roy. Soc., vol. 95, no. A667, Nov. 7, 1918, pp. 155-176, 5 figs. Measurements of intensity of vibrations parallel to existing beam of light scattered at right angles by gases and vapors; particular study of behavior of helium; evaluation of intensity of scattering by different gases in terms of refractivity; photographs of polarizations of ether, vapor and nitrous oxide.

Liquid Films

The Stratification of Liquid Films (La strification des lames liquides), Jean Perrin. Annales de Physique, vol. 10, Sept.-Oct. 1918, pp. 160-184. Result of Johonnott's microscopical examination of soap bubbles; superficial tension of soap solutions; law of multiple thicknesses; chemical separation by simple extension of free surfaces.

Pitched Baseball

A Pitched Baseball, Willard W. Griffin. Sci. Am. Supp., vol. 87, no. 2244, Jan. 4, 1919, pp. 12-14, 3 figs. Mechanical analysis of a "floater" and other curved ball paths.

Radioactivity

The Problem of Radioactive Lead, Theodore W. Richards. Science, vol. 49, no. 1253, Jan. 3, 1919, pp. 1-11. Account of experimental researches; hypothesis concerning disintegration of uranium; hypothetical calculation of atomic weight of uranium-lead; solubility of two kinds of lead nitrate; comparison of properties of different kinds of lead. Presidential address before Am. Assn. for Advancement of Science.

Sound, Standard of

A Possible Standard of Sound, Chas. T. Knipp. Phys. Rev., vol. 12, no. 6, Dec. 1918, pp. 491-492, 1 fig. Adjustment of mercury vapor trap of pyrex glass to furnish sound of desired pitch. From paper presented at meeting of Am. Phys. Soc.

Specific Heat

Specific Heat Determination at Higher Temperatures, Walter P. White. Am. Jl. Sci., vol. 47, no. 277, Jan. 1919, pp. 44-59, 4 figs. Experimental technique at temperatures up to 1400 deg. cent. by method of mixtures; modifications in furnaces and in methods of transferring to calorimeter; variability of heat losses attending dropping of hot bodies into water; use of aneroid calorimeters.

Silicate Specific Heats, Walter P. White. Am. Jl. Sci., vol. 47, no. 277, Jan. 1919, pp. 1-43, 4 figs. Experimental determination for temperatures from 100 to 1400 deg. cent. by dropping from furnaces into calorimeters; checks and precautions employed; two methods for determining true or atomic heats from interval heats. Paper extends scope of writer's previous communications.

The Specific Heat of Platinum at High Temperatures, Walter P. White. Phys. Rev., vol. 12, no. 6, Dec. 1918, pp. 436-441. Redetermination of specific heat from 100 to 1300 deg. cent. with precision of 0.3 per mile. Results agree with those of Gaede, Plato, Corbino, Magnus and Fabaro.

Spectra

The Origin of Spectra, J. C. McLennan. Proc. Phys. Soc. Lond., vol. 31, no. 176, Dec. 15, 1918, pp. 1-29, 14 figs. Outline of investigations undertaken since Frank and Hertz' measurements of mercury-vapor ionization potential and further experimental researches including also vapors of zinc, cadmium and magnesium. Ultraviolet region investigated with a fluorite spectrograph and extreme ultra violet region with a vacuum grating spectrograph. General discussion of results obtained by writer and other investigators.

On the Ultraviolet Spectra of Magnesium and Selenium, J. C. McLennan. Lond., Edinburgh & Dublin Phil. Mag., vol. 36, no. 216, Dec. 1918, pp. 450-460, 2 figs. Records of investigations with Hilger quartz spectrograph and another specially constructed fluorite spectrograph showed 12 new lines in selenium spark spectrum between $\lambda = 2200$ A°. V. and $\lambda = 1850$ A°. U., five lines in selenium are between same limits, and reversal at $\lambda = 2200$ A°. U. in absorption spectrum of selenium metal in carbon arc.

On Fundamental Frequencies in the Spectra of Various Elements, J. C. McLennan. Lond., Edinburgh & Dublin Phil. Mag., vol. 36, no. 216, Dec. 1918, pp. 461-471, 7 figs. Extensive experimental research with photographic records. It is concluded that when zinc and cadmium vapors respectively are bombarded by electrons whose kinetic energy is gradually increased, monochromatic radiation is suddenly emitted by vapor when impact voltage reaches certain value, beyond which no additional relation is produced; also that when a Bunsen flame is fed with vapor of heated zinc, it is possible to obtain monochromatic radiation of wave-length $\lambda = 3075.99$ A°. U.

Welsbach Mantle

A Physical Study of the Welsbach Mantle, Herbert E. Ives, E. F. Kingsbury and E. Karrer. Jl. Franklin Inst., vol. 186, no. 5, Nov. 1918, pp. 585-625, 21 figs. Extension of Ruben's work on thoria-ceria mixtures to large family of such combinations; from investigation of conditions under which visible absorption bands of ceria and other materials appear and disappear, an explanation is offered of different behavior of mantle in flame and cathode-discharge heating; attempt to fix possible attainable efficiencies of gas-light production by present methods (Concluded from p. 438, Oct. 1918.)

See also ELECTRICAL ENGINEERING, Electrophysics (Vapor Arcs).